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CHARLES W. PRICE
PRESIDENT AND TREASURER
STEPHEN H. GODDARD
SECRETARY AND MANAGER
RUSSELL HOWLAND
GENERAL REPRESENTATIVE

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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

Electric progress has made great advances in the army and navy in all the great nations, perhaps more in the United States than any. The uses and applications are innumerable and constantly widening. It would be well to create a division of electricity in both army and navy. Such departments would be able to give valuable service and save vastly more than their costs of administration. The various types of electric plants and apparatus for vessels, fortifications, navy-yards, etc., could be standardized, and the whole domain brought under uniform and efficient control. Splendid material exists for the selection of the personnel of such departments.

ELECTRIC AND OTHER FORMS OF AUTOMOBILES.

Ever since the night when Edison flashed the commercial incandescent lamp on the economic world there has been incessant rivalry between it and the coal gas. Friends of each have put forth the claims of their favorite, yet we have both to-day. Possibly the oxide mantle has saved gas from an overwhelming defeat and proven its elixir. Time alone will tell.

Similarly we see to-day a rivalry between the electric automobile on one side and various heat motors on the other, involving gas in some form. Some of these are driven by explosive mixtures of air and the vapor of gasoline or other liquid hydrocarbon, while others are small steam engines with boilers fired by gasoline. The main difference seems to be in the considerable reduction in size and weight in favor of the steam motor. To our thinking at present the electric type has the advantage from many points of view, and is likely to maintain its position.

Foremost among these is the overwhelming simplicity of the electric system. No such complications as reciprocating pistons, complex valves and governors, and other palpable objections as necessarily accompanying all the usual types of engine motors. The gas-engine motor drags under the handicap of weight. Whether two or four-cycle, it must be heavy. This weight can not well be distributed, like a battery. The driving energy, being in the form of intermittent impulses, imparts damaging shocks to the structure, whether the motor be gas or steam. This is always noticeable to the eye when the motor is set in motion while the vehicle is at a standstill. The odor of gasoline and its products of more or less imperfect combustion seems difficult to overcome. One could almost follow the path by scent alone.

The mechanism necessary calls for much skill and attention to keep in order.

On the other hand, the electric system is free from all such objections. The energy is applied continuously, is uniform and smooth, the motor can be started instantly without any preliminary fussing or annoyance. Operation is quiet. No trail of smoke, steam or odor. The only objections are a limited radius of mileage and uncertainty of recharging stations along the route. Both of these will probably disappear in time.

The electric automobile seems to have the best of it so far.

INCREASE OF TRANSMISSION VOLTAGES.

It is interesting to note the rapid jumps with which the voltages on long-distance transmission lines have been going up.

A few years ago ten thousand was the maximum and considered difficult to handle. To-day forty thousand is practically standardized and sixty thousand is not unusual.

In the old days the alternating-current mathematicians pictured the lively effects that would attend the use of voltages above ten thousand. Resonance would raise Sam Hill and break down all the insulation in the same county with the seat of trouble, leakage would be prohibitively great, insulators would give way and other difficulties numerous and troublesome would cause continued unhappiness to the engineer and perpetual vexation to the investor.

Resonance does not occur with any conceivable operating conditions at commercial frequencies, and though the frequency of the upper harmonics may be of a proper value to produce it, their maximum voltages are so low that the resulting voltage due to resonance—and which is a function of the voltage of the wave producing it—is not in practice appreciable. Leakage is small and insulators are still doing business at the same old stand with sixty-thousand-volt lines on them. Instead of high voltages being dangerous,

they are really safer than moderate voltages, because they are looked on as sources of danger and are more carefully installed and carried over private rights of way and carefully guarded.

All honor to those engineers and capitalists who have had the courage and skill to attempt transmission at these higher voltages and who have shown the way past many obstacles and out of many difficulties.

THE ELEMENTARY STUDY OF ELECTRICITY.

The multitude looks upon electricity with a superstitious awe. The reason is simply that the most elemental principles of electricity are understood by but a comparative few, and when one considers the vast part electricity plays in the present age, it is noteworthy that this ignorance should still surround the meaning of the word "electricity." It is time that children should be carefully taught the simple principles of the production of electricity, and the simpler principles of its applications, as it is so generally used for light, power and signaling. This education should be given in its simplest form to the child mind along with mathematics and first physics. It is time too that adults of the present day, who have not these rudiments, should awaken to a knowledge of them for their own self-respect.

These facts are not hard to master, certainly not more difficult than to understand the action of the tides and a hundred other things in nature that form the daily topics for all classes of people. Electrical phenomena make not one break in the laws of nature; nothing superstitious nor uncanny exists in the subject.

It is hard to explain why this dense popular ignorance of electricity has continued so long, unless it lies in the fact that its apparently vague form of existence and its great inherent capabilities have made it a good subject for superstition and charlatanism. Herbert Spencer has embodied in the words which are likely to be his final ones that superstitions are the enemies of true religions as well as of sciences, and that a perfect knowledge of the sciences is the greatest contribution to the welfare of mankind.

THE BRIDGE PROBLEM AGAIN.

The publication of the Parsons plans for the ultimate relief of the suffering public, again brings up the necessity of adverting to what all these servants of the public should have pounded into their understanding once for all. That is, *the present.* It is all well enough to lay out plans for accomplishment in two, three, or four years. No one will object to that. But we daily face a condition which is intolerable.

One of the regrettable features of American institutions is the fact that when a man is elected or appointed to a position of great public moment he often assumes a supreme indifference to the wants of that public to which he owes his all. It seems incongruous, but it also seems to be true. Apply the theory to our noble bridge. For several years the service has been utterly inadequate. Yet relief has been within the power of the city and its officers. All of them in charge of the bridge are supposed to be experts and to know all the possibilities. Plans for relief have been suggested almost by the hundred; all having more or less merit. But none of the high authorities could see any sense in them, and the waste-basket fattened daily. Intelligent citizens, many of them engineers of quite as much experience and ingenuity as those in charge, have studied the question, and submitted plans, which, whether or not best, would ameliorate the situation. More of the waste-basket!

Other plans are open for action and are not presented because of that inevitable waste-basket. What are we to do? Quite a number of plans have been presented to the bridge authorities and the Brooklyn trolley magnates, and no results.

We believe that plans can be carried out at once which will relieve the situation and give the public what it needs and has the right to demand, namely, proper and adequate handling of the bridge traffic. A few weeks of reconstruction of the original botch at the Manhattan end would work immediate results and put an end to the complaints of dangerous and indecent crowding. A few thousand dollars expended now will change the whole face of nature for the hard-pressed citizens who have to pay the piper.

Let us have some immediate action.

In such large installations as that of the Niagara Falls Power Company all complications should be avoided, and a man should see directly before him that apparatus which is essential to the proper control of the generators and feeder systems. A bench-board system, to cover such a large number of units and so many pieces of auxiliary apparatus as exist in this station, would prevent the operator from immediately placing with his eye the instruments that belong to the apparatus to be controlled. This applies to other large power stations, and by many it is believed that the delay in associating with the bench-board apparatus the proper instruments, detract from the value of using such devices. However, in the smaller plants, where means can be easily provided for connecting the instruments indicating the condition of the machines with their controlling apparatus on the bench-board, it might be desirable to use the latter device. It was brought out at the recent convention of the American Institute of Electrical Engineers that only the apparatus which is essential for the switchboard man to use in controlling his machines should be placed on the switchboard. Wattmeters and recording instruments might better be placed in the superintendent's office rather than on the switchboard.

The ELECTRICAL REVIEW presents in this issue interesting correspondence from London and Paris. It is our desire to present in the letters from these well informed electrical writers the news of the development in the electrical field in Great Britain and on the Continent of Europe. The monthly Export Numbers of this journal will be notable issues in respect to giving a general résumé of the industry and science in all parts of the world.

The fact that the rooms of the King of England were cooled and ventilated, during his severe illness, by means of the electric fan was deemed of sufficient interest to be cabled to numerous daily papers in this country. The electric fan is purely an American invention and its usefulness is becoming more and more appreciated in all countries.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XLV.

BY W. ELWELL GOLDSBOROUGH.

However, we can use Fig. 165 to good advantage in determining the kind and character of the phase diagram which represents the reactions taking place in a two-phase machine when both of its phases are loaded non-inductively, gradually and equally, and the field excitation is kept precisely the same. In fact, the results given by the phase diagram of 166, which indicate the behavior of a machine under the conditions just specified, have been obtained from Fig. 165 by the following process:

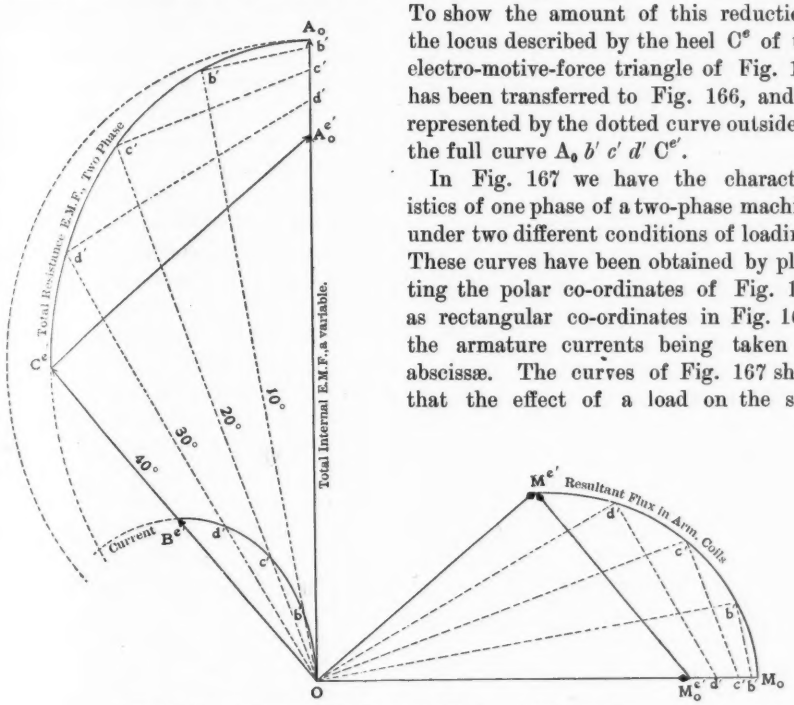


FIG. 166.—ALTERNATING DYNAMO ELECTRIC MECHANISMS.

The b' values of Fig. 166 are obtained from Fig. 165 by reducing the b values of Fig. 165 in the ratio of the vector OM^b_q to the vector OM_0, and, similarly, the e' values of Fig. 166 which represent the conditions existing at full load, where both phases are loaded evenly and non-inductively, are obtained by reducing the e values of Fig. 165 in the ratio of the vectors OM^e_q and OM_0.

In Fig. 166 we see, then, the modification which takes place in the characteristics of one phase of a two-phase machine when both phases are gradually loaded, in contrast with the conditions which exist in the same machine when but one phase is gradually loaded. We see that the effect of the current in the second phase is to successfully reduce, by its reaction upon the field circuit, the effective magnetism which cuts the armature coils of the first phase from OM_0 to $OM^{b'}_0$ to $OM^{c'}_0$ to $OM^{d'}_0$, and, finally, to $OM^{e'}_0$ at full load. The reduction in the total effective flux cutting the coils of the first phase necessarily reduces the value of the total internal electro-motive force developed in the coils of the first phase, and it is therefore successfully reduced from its initial value OA_0 to the values $OA^{b'}_0$, $OA^{c'}_0$, $OA^{d'}_0$, and $OA^{e'}_0$. To show the amount of this reduction, the locus described by the heel C^e of the electro-motive-force triangle of Fig. 165 has been transferred to Fig. 166, and is represented by the dotted curve outside of the full curve $A_0\ b'\ c'\ d'\ C^{e'}$.

In Fig. 167 we have the characteristics of one phase of a two-phase machine under two different conditions of loading. These curves have been obtained by plotting the polar co-ordinates of Fig. 166 as rectangular co-ordinates in Fig. 167, the armature currents being taken as abscissæ. The curves of Fig. 167 show that the effect of a load on the second phase is to reduce the electro-motive force appearing at the collector rings of the first phase, and cause a material drop in this electro-motive force for corresponding currents in the armature. Further, it shows that the same degree of current loading can not be obtained when both phases are active with as slight a lag of the current behind the total internal electro-motive force as when only one phase is loaded. The dotted lines which radiate from the point O intersect the two-voltage characteristics at points corresponding to which the armature currents have the same angle of lag behind the total internal electro-motive force. A consideration of the power curves shows that the maximum power which the first phase can possibly develop is greatly reduced when the second phase is equally and symmetrically loaded. In the present case, this reduction amounts to over 35 per cent in the maximum load capacity of one phase.

Example 27.

Given: A 30-kilowatt alternator developing 1,000 volts at 60 cycles. The armature of tnis machine has a total inductance of .044 henry, 56.7 per cent of which is equal to the average value of the local inductances of the armature, and 43.3 per cent equal to the average value of the field inductance of the armature.

Assuming the inductance factors of the armature to be constant, determine the regulation of the machine when one phase is gradually loaded non-inductively; and also when both phases are gradually loaded non-inductively.

Solution: In solving this problem we will lay off in Fig. 165 the vector OM_0 equal to the field flux Φ_0 entering one pole-face at no load, and at right angles to this the vector OA_0 equal to 1,000 volts. We can now lay off the lines OM^b, OM^c, OM^d and OM^e, lagging respectively 10, 20, 30 and 40 degrees behind the vector OM_0, to points where they intersect the circle $M_0\ b\ c\ d\ M^e$, which is described on OM_0 as a diameter.

If, now, we draw M_0M^b, M_0M^c, M_0M^d and M_0M^e, these vectors will represent the total value of the flux which is set up by currents flowing in the armature as a non-inductive resistance in the external circuit of the first phase of the generator is greatly reduced, while the second phase is on open circuit. If, now, we lay off the distance DM_0 equal to 43.3 per cent of the vector OM_0, and on it as a diameter describe the semi-circle DM^eM_0, this semi-circle will cut the vectors which radiate from the point M_0 into sections which

TABLE 21.

Data pertaining to Figs. 165, 166 and 167.

	$\frac{\Phi_p}{10^4}$ Flux.	$\frac{\Phi_q}{10^4}$ Flux.	E Resistance Volts.	I Current Amperes.	E_0' Total Internal Volts.	E' Resistance Volts.	I' Current Amperes.	P_0 Power Kw.	P_0' Power Kw.
a	0	77	1000	0	1000	1000	0	0	0
b	1	71	985	11	986	971	10.8	10.85	10.50
c	3.6	73.6	938	21.5	950	892	20.4	20.20	18.20
d	7.4	77.4	863	30.6	904	780	27.6	26.40	21.50
e	12.5	82.5	762	39.2	848	647	33.2	29.85	21.50
f	17.7	87.7	640	46.4	799	511	37.0	29.70	18.90
g	22.5	92.5	500	52 5	757	378	39.8	26.20	15.04

are proportional to the field inductance flux and the local inductance flux set up by the armature currents. For instance, $M_0M^e_i$ equals the field inductance flux and $M^e_i\ M_e$ the local inductance flux set up by the armature current per pole when the armature current has a value OB^e.

Now, since in this figure the vectors OC^b, OC^c, OC^d and OC^e represent the electro-motive forces developed by the resultant flux values OM^b, OM^c, OM^d and OM^e, and since the current vectors OB^b, OB^c, OB^d and OB^e represent the currents flowing in the armature for successive variations in the non-inductive load on the machine, it is possible for us by plotting these values in rectangular co-ordinates, as in Fig. 167, to show the regulation characteristic developed by the non-inductive loading of one phase of the machine. Since OA_0 is equal to 1,000 volts when a current OB^e equal to 30.2 amperes is delivered, the electro-motive force in phase with this current OC^e will equal 76.2 volts, and the power developed by this phase will be equal to 29,850 watts. These values represent an overload on the machine, but show the exact voltage and current values under different degrees of loading.

In table 21, we have recorded in the columns headed E and I all the data that are needed to plot the single-phase regulation characteristic shown in Fig. 167, and in the column headed P_0 we have the product of E by I, which is equal to the total power developed by the first phase.

At full load, or when the first phase is developing 15 kilowatts, the voltage at the dynamo terminals is 968 volts (since, in the problem under discussion, we have neglected the ohmic resistance of the armature), which is a little over 3 per cent below the no load voltage of 1,000 volts.

Now, if we refer back to Fig. 165, we can obtain data for a determination of the regulation characteristic when both phases are uniformly and non-inductively loaded. To do this, we project the field inductance flux vectors, as, for instance, $M^eM^e_i$ upon the flux vector OM_0. Now, laying off these projections (as $M_0M^e_p$) in extension of the vector length OM_0, we obtain a measure of the flux which must be set up through the field winding in order that when both phases are being loaded each one may produce a voltage phase diagram like that of Fig. 165; in other words, when a current equal in value to OB^e is being taken from each phase, in order that a collector electro-motive force equal to OC^e shall appear at the collector rings of each phase, the field excitation must be so increased as to make it capable of setting up a field flux equal to $OM_0 + M_0M^e_q$, or OM^e_q. If this additional flux is not added to the exciting circuit when both phases are loaded with currents lagging behind their total internal electro-motive forces by angles equal to the angle AOC^e, the electro-motive forces appearing at their collector rings will be equal to OC^e reduced to the ratio of OM_0 to OM^e_q, and the current OB^e will also be reduced in like ratio. In other words, when only one phase is loaded non-inductively and the armature current lags 40 degrees behind the total internal electro-motive force, it has a value equal to 39.2 amperes, but when the second phase is closed through a similar resistance, the current falls off in value until it equals 33.2 amperes.

If the problem be treated in the same manner for various degrees of loading of the first and second phases non-inductively, a regulation characteristic is developed like that shown in Fig. 166 by the polar co-ordinate curve $A_0\ b'\ c'\ d'\ C^e$, and like that shown in Fig. 167 by the two-phase regulation characteristic. This latter curve is plotted from the data given in table 21, and tabulated in the columns headed E′ and I′. By actual measurement from Fig. 165, the field inductance flux vectors, when projected on OM_0, give the values tabulated in the column headed Φ_0 of table 21. For instance, the distance $M_0M^b_p = 2 \times 10^4$, the distance $M_0M^c_p = 7.2 \times 10^4$, and the distance $M_0M^d_p = 14.8 \times 10^4$, etc. Since the initial field flux $OM_0 = 140 \times 10^4$, the reduction ratios which must be used in determining the final values of the electro-motive forces and currents

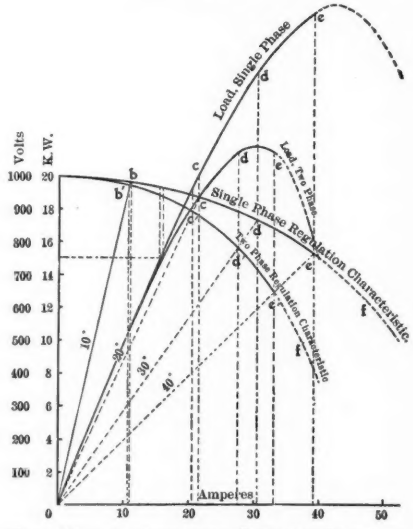


FIG. 167.—ALTERNATING DYNAMO ELECTRIC MECHANISMS.

when both phases are equally and non-inductively loaded and the field excitation is maintained constant are 140 to 142, 140 to 147.2, 140 to 148.8, etc., corresponding to the *b*, *c* and *d* vector values of Fig. 165 respectively. Consequently, in table 21 the *e* value of E′ is obtained by multiplying the *c* value of E by 140, and dividing it by 154 8. In like manner, the *e* value of I′ is obtained from *e* value of I by multiplying it by 140 and dividing by 154.8. To obtain the power developed by the first phase when the generator is operated as a single-phase alternator, the product is taken of the values given in the E and I columns of table 21. They are plotted in the P_0 column of table 21.

Similarly, when the generator is operated as a two-phase alternator, both phases being equally and non-inductively loaded, the power developed by each phase will be equal to the product of the E′ and I′ values of table 21. These are tabulated in the column headed P_0'.

In Fig. 167, the upper load curve represents the power developed by the first phase when the machine is operated as a single-phase generator. The lower load curve shows the power developed by the first phase when the generator is operated as a two-phase alternator, both phases being equally and non-inductively loaded. It is seen, therefore, that the maximum output capacity of the first phase is reduced from 30.4 kilowatts to 21.8 kilowatts by the equal loading of the second phase. With the first phase only carrying a non-inductive load, the collector electro-motive force drops thirty-two volts below its no-load value when the phase is carrying its full load of fifteen kilowatts. When the second phase is also loaded to fifteen kilowatts, the voltage of both phases registers sixty-four volts less than the no-load voltage. Thus, we see that for equal degrees of phase-loading, there is a three per cent drop under single-phase conditions and a six per cent drop under two-phase conditions.

A careful study of the characteristics shown in Fig. 167 reveals many important points with reference to the behavior of a two-phase alternator, non-inductively loaded. The small letters indicate the relative values of the electro-motive-force current and power for the same lag of the armature currents behind the total internal electro-motive force. For instance, the forty-degree line shows that, with the same resistance in the external circuit, the first phase delivers *e* current and power under single-phase conditions, and *e′* current and power under two-phase conditions.

THE PROGRESS OF ELECTRIC SPACE TELEGRAPHY.*

Wireless telegraphy, or telegraphy through space without connecting wires, is a subject which at present is probably attracting more world-wide attention than any other practical development of modern electrical engineering.

That it should be possible to actuate an instrument from a distance of hundreds or thousands of miles and oblige it at will to reproduce audible or visible signals through the effects of electrical oscillations transmitted to it without the aid of any continuous artificial conductor strikes the minds of most people as being an achievement both wonderful and mysterious.

If we examine the subject closely we may, however, come to the conclusion that although telegraphy through space is certainly wonderful, as are likewise all natural and physical phenomena, yet it is certainly in no way more wonderful than the transmission of telegrams along an ordinary telegraph wire. The heat and light waves of the sun and stars travel to us through millions of miles of space, and sound also reaches our ears without requiring any artificial conductor. Is it not, therefore, wonderful that man should have devised means by which he is enabled to confine electricity conveying messages or power to a wire and cause the effect, which we call an electric current, to follow all the turns and convolutions which may exist in the wire?

We find that the first systems of telegraphy used by mankind were truly wireless. A bonfire built on a hill by a band of aboriginal Indians conveyed a signal wirelessly by etheric waves—in this case light waves—to Indians on another hill, perhaps miles distant. Even to-day there are innumerable systems of what may truly be called wireless telegraphy in practical use. A red light at a railway crossing conveys a signal by waves through the ether to the eye of the engine-driver. The red light is the transmitter, the eye the receiver.

The method of space telegraphy of which I intend speaking to-night is founded on a comparatively new way of controlling and detecting certain kinds of etheric waves, much slower in rate of vibration than light waves, called Hertzian waves, after the scientist who first demonstrated their existence.

The mathematical and experimental proof by Clerk Maxwell and Heinrich Hertz of the identity of light and electricity and the knowledge of how to produce and detect certain previously unknown ether waves made possible this new method of communication.

I think I am right in saying that the importance of the discoveries of Maxwell and Hertz was realized by very few, and even, perhaps, so recently as a year ago a great number of scientific men would have hardly foreseen the advances which have been made in so brief a time in the art of space telegraphy.

The time allowed for this discourse does not permit me to describe all the various steps which have made possible the results recently obtained, nor to describe the work of the numerous workers who have contributed to the advance of the subject, but I hope it may be of interest if I describe the various problems which have lately been solved and the very interesting developments which have taken place in my own work during the last few months.

I shall first briefly describe my system as used in my early experiments, six years ago, and afterward endeavor to explain the various improvements and modifications which have since been introduced into it.

The transmitter consists of a modified form of Hertzian oscillator, the main feature of which is in having one sphere of the spark discharger earthed and the other connected to an elevated capacity area or to a comparatively vertical wire. The two spheres are also connected to the ends of the secondary winding of an induction coil or transformer. When the key is pressed the current of the battery is allowed to actuate the spark coil, which charges the spheres and the vertical wire, which when discharging causes a rapid succession of sparks to pass across the spark gap. The sudden release caused by the spark discharge of the electrical strain or displacement created along certain lines of electric force, though space by the charged wire causes some of the electrical energy to be thrown off in the form of a displacement wave in the ether, and as a consequence the vertical wire becomes a radiator of electric waves.

In this connection it is interesting to remember that Lord Kelvin showed mathematically more than forty years ago the precise conditions under which such a discharge as we are considering would be oscillatory.

It is easy to understand how, by pressing the key for longer or shorter intervals, it is possible to emit a long or short succession of impulses or waves which when they influence a suitable receiver reproduce on it a long or short effect according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

The receiver consists of a coherer placed in a circuit containing a local cell and a sensitive telegraph relay actuating another circuit which works a trembler or decoherer and a recording instrument. In its normal condition the resistance of the coherer is infinite or at least very great and the current of the battery can not pass through it to actuate the instruments, but when influenced by electric waves the coherer becomes a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell to actuate the relay which in turn causes another stronger current to work the recording instrument and also the tapper or decoherer which is so arranged as to tap or shake the coherer and in this way restore its sensitiveness. The practical result is that the circuit of the recording instrument is closed for a time equal to that during which the key is pressed at the transmitting station, and in this way it is possible to obtain a graphic, acoustic or optical reproduction of the movements of the key at the sending station. One end of the tube or coherer is connected to earth and the other to an insulated conductor, preferably terminating in a capacity area similar in every respect to the one employed at the transmitting station.

I noticed that by employing similar vertical rods at both stations it was possible to detect the effects of electric waves, and in that way convey the intelligible alphabetical signals over distances far greater than had previously been believed possible, and by means of similar arrangements distances of transmission up to about 100 miles were obtained.

It was soon, however, realized that so long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilization of the system was imposed.

Without some practical method of tuning the stations it would have been impossible to work a number in the vicinity of each other at the same time without interference caused by the mixing of messages.

The new methods of connection which I adopted in 1898, *i. e.*, connecting the receiving vertical wire or aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser so as to form a

*An address by William Marconi before the Royal Institution, June 13, 1902

resonator tuned to respond best to waves given out by a given length of aerial wire, were important steps in the right direction.

I had, however, realized at the time, that one great difficulty in the way of achieving the desired effects was caused by the action of the transmitting wire. A straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves.

In all what we call good radiators, electrical oscillations set up by the ordinary spark discharge method cease or are damped out very rapidly, not necessarily by resistance, but by electrical radiation removing the energy in the form of electric waves.

It is a well-known fact that when one of two tuning forks having the same period of vibration is set in motion, waves will form in the air, and the other tuning fork, if in suitable proximity, will immediately begin to vibrate in unison with the first. In the same way a violin player, sounding a note on his instrument will find a response from a certain wire in a piano near-by, that particular wire out of all the wires of the piano happening to be the only one which has a period of vibration identical with that of the musical note sounded by the violinist. Tuning forks and violins, of course, have to do with air waves, and wireless telegraphy with ether waves, but the action in both cases is similar.

It is very important to take into consideration the one essential condition which must be obtained in order that a well marked tuning or electrical resonance may take place. Electrical resonance like mechanical resonance essentially depends upon the accumulated effect of a large number of small impulses properly timed. Tuning can only be obtained if a sufficient number of these timed electrical impulses reach the receiver. As Professor Fleming so graphically puts it in one of his lectures on electrical oscillations, to "set a pendulum in vibration by puffs of air we must not only time the puffs properly but keep on puffing for a considerable period."

It is therefore clear that a dead heat radiator, *i. e.*, one that does not give a train or succession of electrical oscillations, is not suitable for tuned or syntonic space telegraphy.

As I pointed out before, a transmitter consisting of a vertical wire discharging through a spark gap is not a persistent oscillator. Its electrical capacity is comparatively so small and its capability of radiating waves so great that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it.

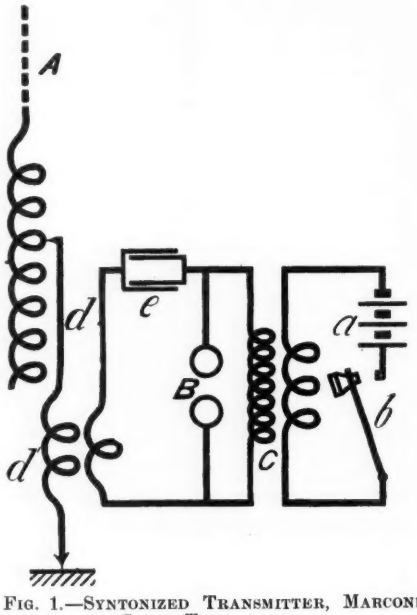


FIG. 1.—SYNTONIZED TRANSMITTER, MARCONI SPACE TELEGRAPHY.

Early in 1900 I obtained very good results with another arrangement in which the radiating and resonating conductors each take the form of two concentric cylinders, the internal cylinder being earthed. By using zinc cylinders only seven metres high and 1.5 metres in

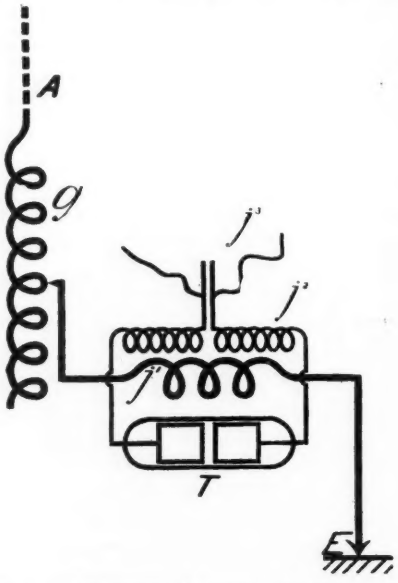


FIG. 2.—RECEIVING STATION ARRANGEMENTS, MARCONI SPACE TELEGRAPHY.

diameter good signals could easily be obtained between St. Catherine's Point, Isle of Wight, and Poole, over a distance of thirty miles, these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the Admiralty in the immediate vicinity.

The capacity of the transmitter, due to the internal conductor, is so large that the energy set in motion by the spark discharge can not all radiate in one or two oscillations, but forms a train of slowly damped oscillations, which is just what is required.

A simple vertical wire may be compared with an empty teapot, which after being heated would cool very rapidly, and the concentric cylinder system with the same teapot filled with hot water which would take a very much longer time to cool.

In the receiver the closely adjacent cylinders which give it large electrical capacity cause it to be a resonator possessing a very decided period of its own, and it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves which are sometimes caused by atmospheric disturbances, and which occasionally prove troublesome during the summer.

Another successful system of tuning or syntonizing the apparatus was the outcome of a series of experiments carried out with the discharge of condenser or Leyden jar circuits. I tried by means of associating with the radiating wire or capacity, a condenser circuit, which is known to be a persistent oscillator, to set up the required number of oscillations in the radiator. An arrangement consisting of a circuit containing a condenser and a spark-gap constitutes a very persistent oscillator. Professor Lodge has shown us how, by placing it near another similar circuit, it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars. But, as Lodge points out, "a closed circuit such as this is a feeble radiator and a feeble absorber, so that it is not adapted for action at a distance." I very much doubt if it would be possible to affect an ordinary receiver at even a few hundred yards.

It is, however, interesting to notice how easy it is to cause the energy contained in the circuits of this arrangement to radiate into space.

It is sufficient to place near one of its sides a straight metal rod or good electrical radiator, the only other condition necessary for long-distance transmission being that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit. Stronger effects of radiation are obtained if the radiating conductor is partly bent round the circuit

containing the condenser (so as to resemble the circuits of a transformer).

My first trials with this system were not successful, in consequence of the fact that I had not recognized the necessity of attempting to tune to the same period of electrical oscillation (or octaves) the two electrical circuits of the transmitting arrangement, these circuits being the circuit consisting of the condenser and primary of the transformer and the aerial or radiating conductor and secondary of the transformer. Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver. The syntonized transmitter is shown in Fig. 1. The period of oscillation of the vertical conductor A can be increased by introducing turns of wire, or decreased by diminishing their number, or by introducing a condenser in series with it. The condenser in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity.

The receiving station arrangements are shown in Fig. 2. Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I place an adjustable condenser across the coherer in Fig. 3. Now in order to obtain best results it is necessary that the free period of electrical oscillation of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser. I stated that in order to make the tuning more marked a condenser is placed across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble but properly timed electrical oscillations being received the effect of the same is summed up until the electro-motive force at the terminal of the coherer is sufficient to break down its insulation and cause a signal to be recorded.

In order that the two systems, transmitter and receiver, should be in tune it is necessary (if we assume the resistance to be very small or negligible) that the product of the capacity and inductance in all four circuits should be equal.

It is easy to understand that if we have several stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit to any one of them, without danger of the message being picked up by the other stations for which it is not intended. But better than this we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wire a number of corresponding receivers.

Different messages can be sent by each transmitter connected to the same radiating wire simultaneously and received equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe was

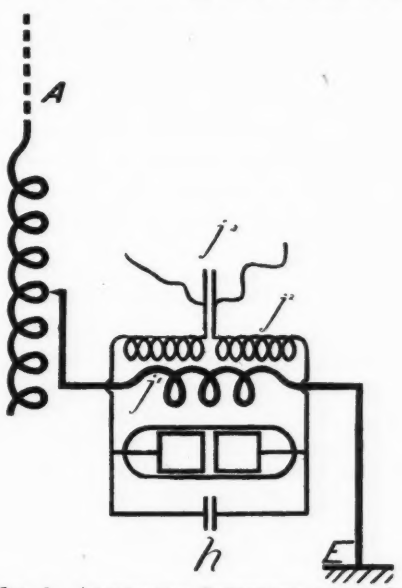


FIG. 3.—ADJUSTABLE CONDENSER ACROSS COHERER, MARCONI SPACE TELEGRAPHY.

quite novel at the time, I showed to several friends of mine including Dr. J. A. Fleming, F. R. S., nearly two years ago. Dr. Fleming made mention of the results he had seen in a letter to the London *Times*, dated October 4, 1900.

I have further noticed that the tuning can be further improved by the combination of the two systems described. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly tuned induction coil, and all circuits must be tuned to the same period as already described. This arrangement is going to be further tested in long-distance experiments shortly to be undertaken between England and Canada.

The syntonic systems have not been applied generally to ships, as it has always been considered an advantage that each ship should be able, especially in case of distress, to call up any other ship or ships which may happen to be at the time within the range of its transmitter, but in the case of land stations the syntonic method has been applied in several instances where necessity demanded it. Thus at the testing stations which maintain communication between St. Catherine's, Isle of Wight, and Poole, in Dorset, when electric waves of a certain frequency are used no interference whatever can be caused by the working of the Admiralty installations in the vicinity. The long-distance station at Poldhu, Cornwall, is able to transmit signals decipherable on a tuned receiver on a ship at over 1,000 miles distance, while the Lloyds wireless station at the Lizard, only seven miles away, is not affected by the powerful waves radiated from Poldhu if tuned to a different frequency.

I am not at all prepared to say that under no possible circumstances could a wireless message transmitted between syntonic instruments be tapped or interfered with, but I wish to point out that it is now possible to work a considerable number of wireless telegraph stations simultaneously in the vicinity of each other without the messages suffering from any interference. Of course if a powerful transmitter, giving off waves of different frequencies, is actuated near one of the receiving stations it may prevent the reception of messages, but the ordinary systems of communication through wires may be likewise affected.

I shall now say a few words on the subject of the detector of the electric waves, called sometimes "the electric eye," which consists of that essential part of the receiving apparatus especially affected by the electrical oscillations.

In all wireless telegraph apparatus used up to quite a recent date, a detector now called a coherer has been employed. This detector is based on discoveries and observations made by S. A. Varley, Professors Hughes Colzecchi, Onesti and especially Professor Branly. Professor O. Lodge has made large use of this apparatus which he first named "coherer" in the very numerous experiments and studies he has carried out on the effects produced by Hertzian waves.

The form of coherer I have found most trustworthy and reliable for long-distance work consists of a small glass tube about four centimetres long into which two metal pole pieces are tightly fitted. They are separated from each other by a small gap which is partly filled with a mixture of nickel and silver filings.

Provided such a coherer is properly constructed and the tapper and relay in

good adjustment it proves to be quite reliable when within the range of the transmitting station.

Experiments with syntonic systems have, however, shown that certain kinds of coherers can be far more advantageously employed than others. One apparently all-important condition is that the resistance of the coherer in its sensitive state or after being tapped should appear to be infinite when measured with an electro-motive force of about one volt.

If the tapping does not entirely do away with the conductivity of the filings very poor results are obtained, which can be explained as follows: According to the systems I have described electrical syntony between the transmitter and receiver is dependent on the proper electrical resonance of the various circuits of the transformers used in the receivers. The condenser and secondary of the transformer must not be partially short-circuited by the coherer, otherwise the oscillations can not mount up or sum up their effects as is essential in order to produce the difference of potential at the ends of the coherer necessary for breaking down its resistance, but the electrical oscillations will leak across the conductive coherer without causing it to record any signal. Of course the condenser is short-circuited when the filings cohere under the influence of the received oscillations, but in this case the signal is already recorded and the tapper at once restores the coherer to its non-conducting condition and in this way restores its sensitiveness.

By using coherers containing very fine filings the necessary condition of non-conductivity when in a sensitive state is obtained.

Coherers have lately been tried which will work to a certain extent satisfactorily without the necessity of employing any tapper or decoherer in connection with them. Nearly all are dependent on the use of a carbon microphonic contact or contacts which possess the curious quality of partially reacquiring spontaneously their high resistance condition after the effect of the electrical oscillations has ceased. This enables one to obtain a far greater speed of reception than is possible by means of a mechanically tapped coherer, the inertia of the relay and tapper which are used in connection with it being necessarily sluggish in their action.

In all these self-decohering coherers a telephone which is affected by the variations of the electric current, caused by the changes in conductivity of the coherer, is used in place of the recording instrument.

It has not yet been found possible, so far as I am aware, to actuate a recording instrument or relay by means of a self-restoring coherer.

The late Professor Hughes was the first, I believe, to experiment with and receive signals on one of these coherers associated with a telephone. His experiments were carried out as early as 1879 and I regret that this pioneer work of his is not more generally known.

Other self-restoring coherers were proposed by Professors Tommasina, Popoff and others, but one which has given good results when syntonic effects were not aimed at was (according to official information communicated to me) designed by the technical personnel of the Italian Navy. This coherer at the request of the Italian Government I tested during numerous experiments. It consists of a glass tube containing plugs of carbon or iron with between them a globule of mercury.

These non-tapped coherers have not been found to be sufficiently reliable for regular or commercial work. They have a way of cohering permanently when subjected to the action of strong electrical waves of atmospheric electrical disturbances and have also an unpleasant tendency toward suspending action in the middle of a message. The fact that their electrical resistance is low and always varying, when in a sensitive state, causes them to be unsatisfactory for the reasons I have already enumerated when worked in connection with my system of syntonic wireless telegraphy.

These coherers are, however, useful if employed for temporary tests in which the complete accuracy of messages is not all-important and when the attainment of syntonic effects is not aimed at. They are especially useful when using receiving vertical wires supported by kites or balloons, the variations of the height of the wires (and therefore of their capacity) caused by the wind making it extremely difficult to obtain good results on a syntonic receiver.

Coherers have long been considered as constituting almost the essential basis of electric space telegraphy, and although many detectors of electric waves existed, none of them possessed a sensitiveness which even approached that of a coherer and most of them were also unsuitable for the reception of telegraphic messages.

With a view to producing a receiver which could be worked at a much higher speed than a coherer, I was fortunate enough to succeed in constructing a magnetic detector of electric waves, based on a principle essentially different from that of the coherer and which I think leaves all coherers far behind in speed, facility of adjustment and efficiency when worked in tuned circuits.

The magnetization and demagnetization of steel needles by the effect of electrical oscillations has long been known and was noted especially by Professor T. Henry, Aloria, Lord Rayleigh and others. Mr. E. Rutherford also has described a magnetic detector of electric waves based on the partial demagnetization of a small core composed of fine steel needles previously magnetized to saturation. By means of a magnetometer Mr. Rutherford succeeded in 1895 in tracing the effects of his electrical radiator up to a distance of three-quarters of a mile across Cambridge.

But Mr. Rutherford's arrangement is not suitable for the reception of telegraphic messages in consequence of the fact that a careful process of remagnetization, which requires some time to effect, is necessary in order to restore its sensitiveness after the receipt of each impulse. Mr. Rutherford's arrangement is also considerably less sensitive than a coherer.

The detector which I am about to describe is, in my opinion, based upon the decrease of magnetic hysteresis which takes place in iron when under certain conditions it is exposed to the effect of high frequency oscillations or Hertzian waves.

As employed by me, it has been constructed in the following manner: On a core of thin iron or steel, but preferably hard drawn iron, are wound one or two layers of thin insulated copper wire. Over this winding, insulated material is placed, and over this again another longer winding of thin copper wire contained in a narrow bobbin. The ends of the winding nearest the iron core are connected one to earth and the other to an elevated conductor, or they may be connected to the secondary of a suitable receiving transformer or intensifying coil, such as are employed for syntonic wireless telegraphy. The ends of the other winding are connected to the terminals of a telephone or other suitable receiving instrument. Near the ends of the core or in close proximity to it is placed a horseshoe magnet, which by a clockwork arrangement is so moved or revolved as to cause a slow and constant change or successive reversals in the magnetization of the piece of iron.

(To be continued.)

WHAT IS NEEDED BY THE INDEPENDENT TELEPHONE INTERESTS.

BY A. E. DOBBS.

Early in 1897 the independent telephone men of the United States were widely scattered and isolated from each other. There was a painful lack of capital, and the apparatus was anything but ideal in design or workmanship.

Under these circumstances the independent men found it necessary to get together in order to present a solid front to their common enemy. United action was necessary in order to defend themselves against suits for infringement of the Berliner and other patents, and for the next four years all of their attention was taken up by these matters. The year 1902, however, finds them in a different position. The patent suits are all practically won, while other patents expiring every day are leaving detail parts more and more free to all comers. Until the Berliner patent, however, is finally out of the way in the court of last resort, it is well that the fighting policy of the independent companies should be continued. Laying aside the possibility that the Berliner patent may be won by the Bell company, the independent companies are no longer in the position of under dog in the fight. The number of telephone instruments owned by independent companies to-day is nearly twice the total instrument output of the Bell company. The amount of capital involved in independent exchange construction, leaving out long-distance lines, exceeds that of all the Bell licensees put together, and in nearly every case they have the united support of their local constituencies.

Under this condition of affairs, would it not be well for the convention to drop the purely fighting policy which has heretofore held it together, and turn attention to matters of more immediate interest to exchange owners? Many of the independent men have come into the field with no practical experience in telephone matters, and such men need advice as to the construction and management of their plants a great deal more than to hear the story of a local fight in some remote state, interesting as that might be. Not that the policy of helping men who are engaged in a fight against great odds in undeveloped territory should be abandoned. That is still necessary, and such men should receive all the help that can be given them; but in the great, rich and populous Middle West, where the fight has been won, old animosities should be no longer referred to. But many exchanges need help in the matter of marketing their securities, reconstructing such parts of their plants as need rebuilding, the standardizing of construction that will permit of a quick and reliable interchange of communication between themselves and neighboring exchanges, and by the standardization of apparatus—not for the purpose of obstructing progress or the shutting out of new inventions—but to issue rules for the guidance of managers, so that exchanges constructed in northern Wisconsin may be able to communicate with southern Illinois or western Pennsylvania.

All of the members who have attended these national conventions have shown a keen interest in the acquiring of technical information. This is proved by the fact that when papers on policies, etc., are read in the convention scarcely a baker's dozen of the members can be induced to attend, although the absentees can be found in large groups looking at the various exhibits. Of course the exhibits are an important, attractive and very necessary feature, or otherwise I fear that some of the conventions would fall flat. But when members have come long distances to attend conventions they should be made to feel that they had learned of some decided advance in the art. It seems a pity that at the recent convention Mr. Stanton's paper, hastily prepared by request, was the only technical paper on the programme. It ought to be as easy for the National Telephone Association as for the Electric Light Association, to procure papers of great technical value, because some of the brightest telephone men in the world can be found in the independent field. There should also be connected with the association—although it might properly be left to the state associations—a testing bureau designed to standardize telephone apparatus.

Suppose it was desired to test a telephone in long-distance transmission. It would be comparatively easy to build an artificial line, having approximately the same distributed capacity, resistance and leakage as lines 1,000 miles long now building throughout the country. Suppose that it should be decreed, that in order to receive official approval, any instrument made by a manufacturer must stand a capacity-resistance test of 30,000 ohms. If a manufacturer were to bring his instrument to the laboratory for approval and it failed to pass this test, he surely could not justly complain if he did not get his instrument officially listed. The standard need not be placed so high that any conscientious manufacturer could not reach it. Tests of wire, insulators and other materials might also form the subject of experiment.

In the matter of toll-line practice standard specifications should also be adopted. By following along conservative lines, in order not to work too great a hardship, a much higher standard of construction than now obtain in many localities would soon become manifest. It might be well to also adopt a rule that exchanges, whose instruments and construction were not equal to those recommended by the association, should be cut off from general toll-line service until put in proper condition. It is not enough for their owners to say that an exchange gives satisfactory local service. Farmers have been able to get a very satisfactory local service over wire fences, but that, while a very great convenience to themselves, would not justify other exchanges in giving them recognition as a legitimate telephone company entitled to exchange long-distance business, for every manager knows that such connections would produce unsatisfactory service, injure his business in the estimation of the public who, not knowing that the fault lay in the fence-wire construction, would blame the exchange for all the trouble. Such exchanges do the independent telephone men more harm than good.

It would be comparatively easy for the state association to appoint a general inspector for each state, whose duty would consist in bringing all the exchanges within his territory to conform to standard practice.

To the objection that such a plan of action would cost a great deal of money, not at present available, it can be answered that once convinced that the association was in earnest in trying to raise the standard of construction and service, the members would furnish the means to carry it out.

A great deal of money is now being wasted by exchanges in procuring what they suppose to be the best, only to find afterward that they have made a costly mistake in selecting materials and apparatus not suited to their particular needs.

The association might also well look to the founding of an information bureau, where telephone securities could be listed, and information as to the various exchanges kept constantly on hand.

Telephony has passed the sentimental stage, and is now a matter of business; and while rivalry between the old and the new companies should lose none of its spirit of fair aggressiveness, yet the attention of the national association should be taken up with other matters than that of warfare which has now become ancient history.

Electrolytic Production of Alkali in Great Britain.

By Our Special Correspondent.

THE Electrolytic Alkali Company, of Middlewich, Cheshire, which some years ago erected an experimental plant at Farmworth, in Lancashire, for the exploitation of the Hargreaves-Bird process for the electrolytic production of bleach and soda from common salt, opened early in 1901 the present plant at Middlewich, and this latter having been put at the disposal of visitors quite recently, the following particulars of the commercial installation are interesting.

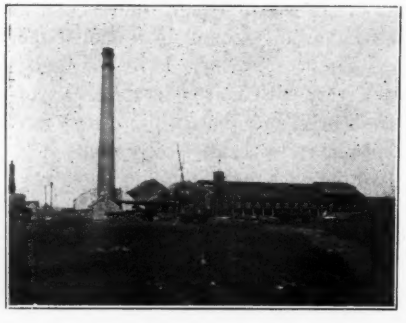


FIG. 1.—THE WORKS OF THE ELECTROLYTIC ALKALI COMPANY, MIDDLEWICH, CHESHIRE, ENGLAND.

The particular cell used is of the shape of a long, deep, iron trough of three longitudinal compartments, two of which are small cathode chambers, and the larger one, the anode, fifteen inches wide, this latter being in the centre and protected by a large diaphragm sheet. The system consists in the direct pumping of brine into the cells, the electrolytic decomposition yielding commercial soda and chlorine. In Cheshire the brine can be pumped up almost anywhere. The diaphragm of the cell, invented by the late Mr. Bird, is made of asbestos and is a feature of the process. Great hydrostatic pressure is brought to bear upon this and it only allows the sodium ions to pass into the cathode chamber, the brine which is fed into the anode being kept out. The soda carbonate obtained through flushing the cathode chambers with steam and carbonic acid gas is concentrated in the usual way. The chlorine gas is absorbed by lime in the bleaching powder plant.

FIG. 2.—THE VAT ROOM OF THE ELECTROLYTIC ALKALI COMPANY, MIDDLEWICH, CHESHIRE, ENGLAND.

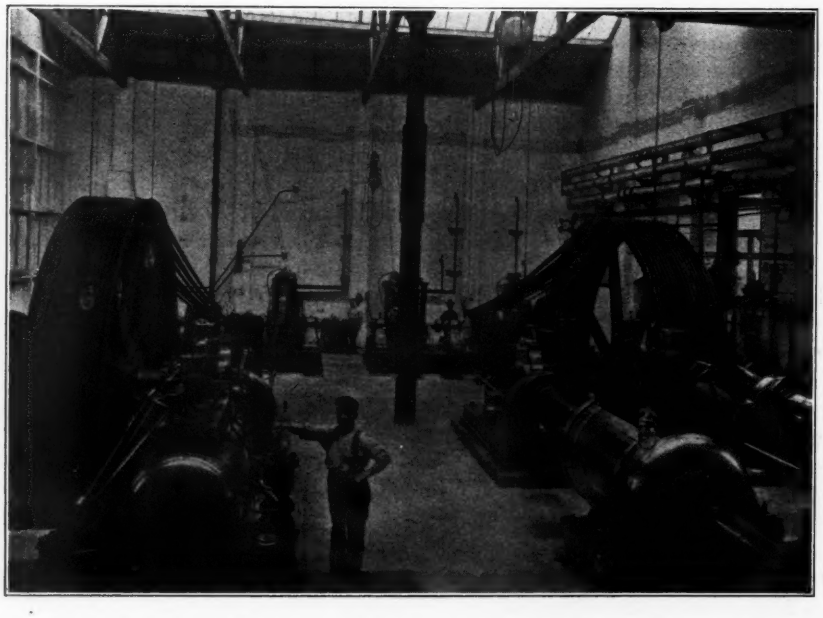


FIG. 3.—THE POWER ROOM OF THE ELECTROLYTIC ALKALI WORKS, MIDDLEWICH, CHESHIRE, ENGLAND.

At the Middlewich works there are fifty-six cells, producing an average of fifty-five tons of bleach and eighty-two tons of soda per week. In addition there is a similar number of cells waiting to be put into operation, the delay being due to the size of the generating plant, which is also being enlarged. The arrangement of the cells is well seen in Fig. 3. They are hermetically sealed, and the absence of any smell is testified to by the fact that the workmen lean against them to eat their dinners. Each cell holds about 300 gallons, and electrically fourteen of them are in series connection. The brine contains about twenty-five per cent sodium chloride. The measurements of the cells as now erected are, five feet high and ten feet long, the framing being of cast iron. Under the works rock salt was

found at a depth of 148 feet, and any well sunk there yields good brine. The Pohle system is adopted, with a ten-inch pipe and three-inch air pipe, and by this means the pumping costs threepence per 1,000 gallons of brine which contains 3,000 pounds of salt. The construction of the anode of the Hargreaves-Bird cell is kept a secret.

The bleaching chambers (Fig. 2) are fed with the chlorine by a double system of earthenware pipes, earthenware exhausters maintaining the necessary circulation. As seen in the illustration the casks are filled with bleaching powders underneath the chambers by means of trap doors.

The power plant (Fig. 3) consists of two 480-horse-power horizontal cross-compound engines, rope driving two Scott & Mountain 480-kilowatt continuous-current dynamos working at 2,000 amperes and sixty volts. This plant will soon be doubled, for which there is ample room. Lancashire boilers are employed, and experiments have been made with automatic stoking and American underfed stoking. The latter is said to have yielded the best results.

The fifty-six cells now installed have, during the past six months, yielded a profit of nearly £9,000 per annum.

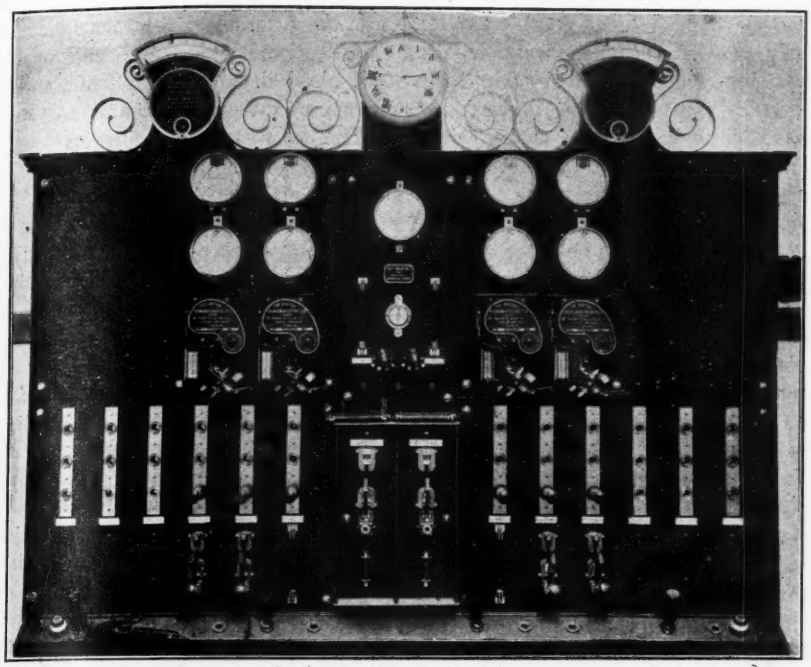


FIG. 1.—THE MAIN SWITCHBOARD AT THE POWER STATION, ALLOA, SCOTLAND.

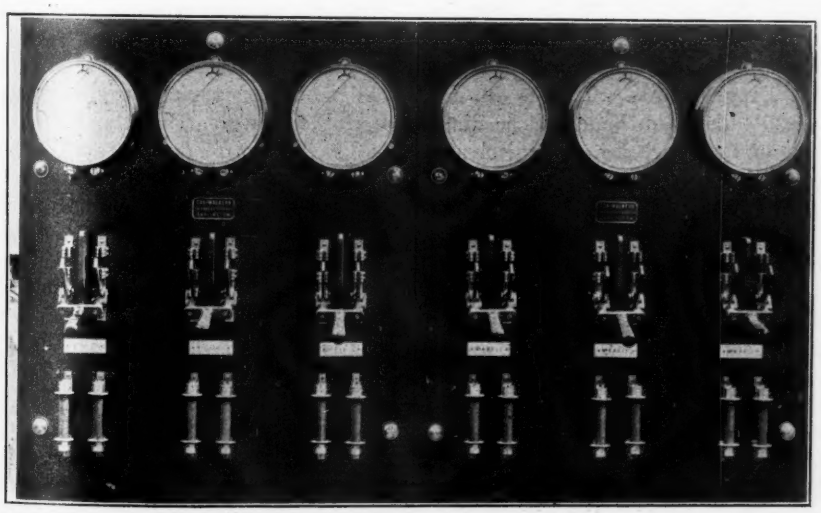


FIG. 2.—THE ARC SWITCHBOARD AT THE POWER STATION, ALLOA, SCOTLAND.

An Interesting Scotch Electric Light Installation.

[*From Our Special Correspondent.*]

The photographs and descriptive matter herewith deal with an interesting little installation in the Scotch burgh of Alloa. There are many towns—both small and comparatively large ones—in Great Britain which obtain their supply of electricity for lighting and other purposes from the plant installed in some local works of a manufacturing nature, but this is the first local authority to take a "bulk" supply from such a source and undertake its own distribution from a substation. As an instance of common sense and financial economy it is worthy of notice, taking into account the numerous failures in connection with complete installations carried out by many very small towns here.

The population of Alloa consists of some 14,000 souls, chiefly engaged in yarn spinning and brewing, and since 1828 gas, which is supplied here at a cheaper rate than in any other Scotch town, has been the illuminant. In 1898, however, a provisional electric lighting scheme was put into preparation by which gas-driven sets were to be adopted, and in 1899 an order under the Board of Trade was obtained. At this time an extensive electrical manufacturing works were being

FIG. 3.—THE ARC PILLAR INSTALLED AT ALLOA, SCOTLAND.

erected in the town by the British Electric Plant Company, in which an electric lighting and power plant was also being installed, and the Alloa Town Council coming to terms with the company for a supply in "bulk" were thus enabled to lay a greater mileage of mains at the outset and still run the undertaking as a municipal one, thereby obviating the necessity of having to buy out the company, had the ordinary methods of company supply been followed, and the provisional order transferred. The necessary arrangements were concluded in 1900 and the light switched on at the beginning of this year.

The generating plant at the works of the British Electric Plant Company is laid out on standard lines and presents no distinguishing features, and the following brief particulars therefore only deal with the distributing network and system of supply in the town of Alloa. The three-wire system has been adopted, and into the switch room of the Town Council three-core positive and negative feeder cables are run, balancing being effected at the British Electric Plant Company's works. The switch room in question comprises a store and test room. The main and arc switchboards inside this room are shown in Figs. 1 and 2. Any subfeeder may be isolated from the network, while a battery of accumulators as well as additional feeders can be switched in without disturbance to the existing panels. The mains in the principal streets are three single distributors of 0.125, 0.86, and 0.125 square-inch section, smaller cables supplying the remainder of the town, the whole being laid solid in iron troughs with tiled covers. Spareways on the Callender-Webber three-way type have been laid. The Crompton arc lamps, a view of which is seen in Fig. 3, are controlled in groups of four. The methods of charging are as follows: Lighting, sevenpence per unit for the first hour and threepence afterward; power, sevenpence per unit for the first hour and twopence afterward, both on the Wright maximum demand system of charging. In addition to this, a specially low rate on the "flat" system is available for those consumers of "power" who undertake not to use their motors during the time of "peak." The entire undertaking has not exceeded £10,000 in cost, a sum which includes the substation machinery and incidental expenses. Messrs. Buchan & Hogarth, of Edinburgh, have advised the Alloa Town Council from the inception of the idea of electric lighting.

Any incandescent electric light will burn under water at any depth if the wires and the lamp are protected from getting wet.

The Universal Exposition of 1904 Commemorating the Louisiana Purchase of 1803.—II.

The water-courses of the grounds, radiating from three great cascades, offer a mile of continuous water circuit. From the roughly semi-circular basin into which the cascades plunge, two streams, in imitation of a natural river, branch to right and left. As they traverse the avenues their banks assume a regular geometrical outline to their debouchure into the grand basin at its lower end.

The beautiful wooded areas on the highest levels of Forest Park are to be occupied by the state and foreign buildings.

The main entrance to the exposition is to be on the side toward the city, where the exposition site abuts the finished portion of the Forest Park. A monumental entrance of magnificent proportions and design, the work of Chief Architect Taylor, will be located here. The two exhibit buildings immediately within this great portal will be crowned by towers 400 feet high, which will form a part of the picture of the monumental entrance.

The cost of the exposition buildings has been estimated at $7,000,000. Most of them will be larger than those constructed for similar purposes at Chicago in 1893. The largest structure at the Columbian Exposition was the Manufacturers and Liberal Arts Building, covering an area of about thirty acres, the dimensions being 787 by 1,687 feet. The Agricultural Building of the St. Louis world's fair will be 700 by 2,000 feet, covering nearly thirty-two acres. The Agricultural Department of the Columbian Exposition had what was called an annex to the main building, the dimensions of the two being, respectively, 556 by 314 feet and 800 by 500 feet. The cost of the two was $699,316.75.

The Mines and Metallurgy Building will cover 400,000 square feet. The one at Chicago covered only 245,000 square feet, and its total cost was $265,000. The Educational Building, with an area of 160,000 square feet, and its annex, the Social Economy Building, covering 160,000 square feet more, will give the Educational Department 320,000 square feet of ground floor. The Educational Building at the Columbian Exposition covered only 105,850 square feet and cost $120,000. The Transportation Building will cover 720,000 square feet against the Columbian's 245,760 square feet.

The contract for the Textile Building has just been let. It covers an area of 525 by 600 feet, and the contract price for its construction is $600,000. In addition to the buildings already named there will be separate buildings for art, mines and metallurgy, liberal arts, varied industries, machinery, forestry, game and fish, the government, fish commission, administration, congresses, anthropology and physical culture. Most of these are shown on the ground plan.

The exposition authorities are giving special attention to the illumination of the grounds, buildings and the electric fountains. Contracts have already been entered into which provide for a supply of 30,000 horse-power. This will be entirely utilized in producing the illumination and providing for the fountains, and in supplying such power as is needed for special purposes and to meet the demands of the exhibitors. The power available is so greatly in excess of that previously utilized in such undertakings as to be productive of a display lavish in the extreme.

The Electricity Building is located on the central avenue of the exposition grounds, and is one of the leading elements of the main exposition picture. The eastern exposure of the building faces the main lagoon, while the southern exposure fronts upon the ground basin and is in direct view of the electric fountains, the peristyle of the Festival Hall and the Art Building. On the east and north the building faces the lagoons, and is consequently entirely surrounded by water. No other exposition building is within 300 feet of its approaches.

The architects of this building are Walker & Kimball, of Boston and Omaha, who were the chief architects of the Omaha Exposition. They have given the design a bold columnated treatment of the Corinthian order. The columns are carried well down toward the ground to give height to the façades. The façades are accentuated by elevated pediments and tower effects over the four main entrances and at the corners. Over the accentuated places, as well as over the twin columns, opportunity for ample sculptural decoration is supplied. The twin columns form a pleasing variation of the façades, and are so situated as to provide ample space for the placing of statuary between each pair.

The fenestration is bold and appropriate, giving ample and substantial wall treatment. On two sides of the building are loggias which add pleasing effects of light and shade. There are numerous openings in the façades such as exhibitors always seek in selecting their exhibit space. The plan of the building provides for an open central court which will be entirely surrounded by colonnades and

made beautiful by masses of flowers. The court is expected to be a most pleasing feature, and to provide a quiet retreat and resting-place for visitors from the thronged corridors and avenues.

The building is simple and well treated, and for it a scheme of indirect illumination is being worked out which will accentuate at night its beauty as seen by day. It offers exceptional opportunities for these effects of which advantage will be taken.

The design of the building is peculiarly well adapted for an effective display of exhibits and is planned to make each of the 350,000 square feet of floor space available.

As at present outlined the scheme for the arrangement of exhibits provides for the placing of the lighter exhibits in the north corridors. The more massive exhibits will be given space in the east and the west corridors, while the heavy machinery will be massed in the south corridors. A tentative plan provides for the placing of the foreign exhibits in the east and southeast quarter of the building. This arrangement will mass the more impressive foreign and domestic exhibits at points admirably suited for a ready comparison without throwing the home products in direct contrast with those of participating nations.

In the east, north and west corridors the exhibition space will be laid off in five long sections separated by wide central passages and less pretentious side passages, cross-connecting spaces being left opposite the side and corner entrances. It is not the present intention to prearrange passages in the southern end of the building where heavy operating units, switchboards and controlling appliances will have space. These will be placed with the idea of rounding them into an imposing and effective display rather than of setting them relative to a predetermined system of platforms and passageways.

It is not so much the intention to fill the building so much with machinery and appliances on exhibition as to bring together within it such typical processes in the manufacture of electrical machines and appliances as will represent in the highest sense a picture of the active life and vigor which the electrical industry now presents to the world throughout the length and breadth of these United States. It was well said by Sylvanus Thompson, one of the greatest of the engineers visiting this country during the time of the Columbian Exposition, that the electricity exhibit of America was not so much in what had been brought together at the exposition as in what was seen by the foreigner on every hand; in cities, towns, villages and highways. If this was true ten years ago it is true to a far greater extent now than ever. Yet it is hoped that the exhibits in the Electricity Building will be in line with that evidence of the existence of a great vital force among us, which has made America famous, and that it will be not an exhibit of things built but of things building, an exhibit of progressive thought, action and evolution, rather than an exhibit of products, which, being finished specimens of our handicraft, are typical, not of the future, but of the past. It is hoped that the engineers of our world renowned factories and operating companies will lend their energies to the perfection of a scheme whereby they can show to the visitors of the exposition at least one important process which has become characteristic of the electrical work over which they preside. With this the central feature of the exhibit, fostered by them, ample opportunity will be afforded for grouping about it evidence of a more extensive participation in the electric industries than the working exhibit will be evidence of. It is beyond question a fact that working exhibits are to the exhibitor worth vastly more than dead exhibits. The former attract the interest and hold the attention of the visitor. They draw spectators from the avenues, the lagoons and the colonnades to the buildings, and do much toward bringing to a successful issue the purposes to which a universal exposition is primarily committed.

The space in the building will be free to exhibitors, and they will be granted free power for the operation of working exhibits, when it can be shown that their exhibits have been worked up to a point of perfection where they are really typical of the processes they purport to exemplify.

The heartiest cooperation will be extended to all exhibitors who have the success of their exhibits at heart, and who are working for the advancement, not only of the particular field in which they are engaged, but also for the prosperity of general and related electrical industries.

Beginning with the less ponderous processes in the northern corridors a progressive arrangement of the exhibits will be made with the idea in mind of rounding the whole into a well-organized progression, culminating in a fine expression of the massive products of which electrical engineering is productive.

Advantage will be taken of the arrangement of the building to bring out with special force the relative effectiveness of the several forms of illumination by electricity. A division of the corridors will admit of the exploitation of arc light illumination, Nernst lamp illumination, incandescent lamp illumination and tube illumination. It is expected that the illumination effects so produced can be blended in a way to heighten the effect of the building and its contents.

Electricians and the friends of electricity will not be disappointed in their hopes of seeing all that is new and important in the field of applied electricity. Negotiations are already in progress looking toward a far more comprehensive showing of these features of electrical achievement which appeal most strongly to the scientist and the layman alike than has ever been attempted. It is too early to speak with certainty of the plans of the department in this respect, but no reasonable exercise of thought, energy or money will be withheld to make the electrical displays of 1904 surpass those of other years.

The Scarcity of Scrap.

The scarcity of scrap iron on this side of the ocean is due to the fact that the extensive building of open hearth furnaces has created a demand for this old material which the country can hardly supply for a long term of years, providing, of course, that the demand for finished material continues strong. In this process basic iron and scrap are used for the manufacture of most grades of steel, and the result has been a demand for these that has fairly cleaned the country of scrap and raised the price of basic iron greatly. At present the world at large is drawn upon to meet the demand of the open hearth furnaces, and old steel rails command a price that is very near that of finished new rails.

The result of this condition is certainly that the profits of the open hearth process are minimized, because they have to pay so much for material that cost them very little a few years ago. In the end it will probably result in the limitation of the number of open hearth furnaces put in commission, and a more even distribution of steel manufacture between this process and the Bessemer process. Of course both will continue to be used, because the open hearth process makes better steel of very high and very low carbonized grades, while Bessemer is much better in the middle grades.

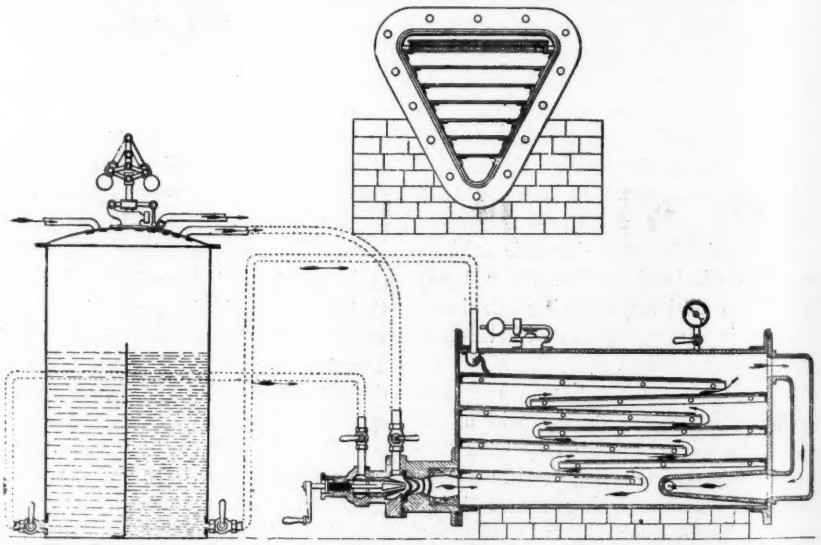
For storage liquid fuel has a slight advantage over coal. It has been approximated that one ton of liquid fuel will require thirty-six cubic feet of storage and steam coal from forty-three to forty-five cubic feet.

Electrical Notes from Europe.

By Our Special Correspondent.

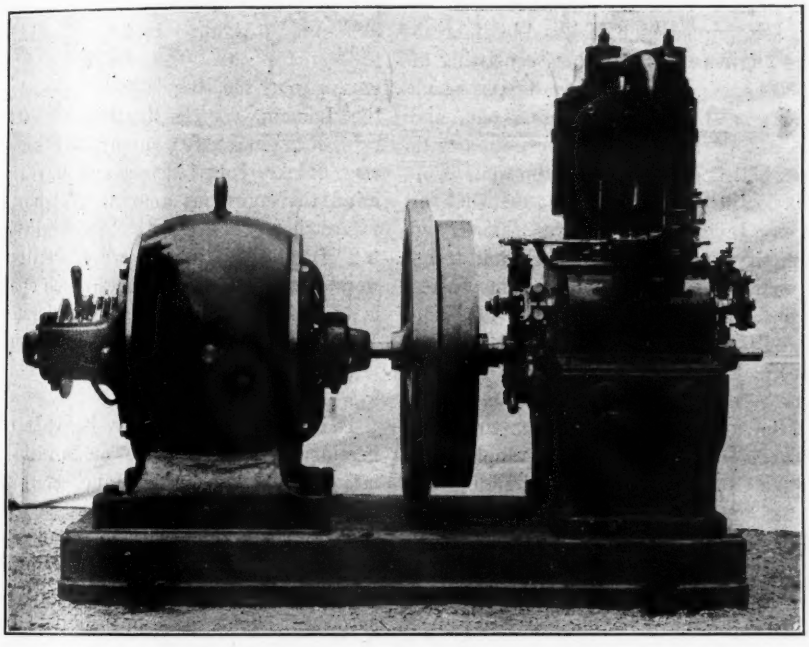
THE development of electric traction in Paris has been very rapid within the last few years. Two or three years ago there were scarcely any electric traction systems in use in the city, and horse cars and omnibuses were still to be seen, with a few steam and compressed air systems. This was mainly due to the fact that the trolley was forbidden inside the city limits, but after the development of the conduit and surface contact systems the progress was rapid, and now the whole city is traversed by lines of electric tramway. A good part of the lines have been installed by the Thomson-Houston Company, and these use either underground conduit or accumulators. Surface contact, on the Diatto and other systems, after having considerable difficulty at first, is now used on several lines. Electric railways commenced to develop about the same time, starting with the Orleans underground, then came the Metropolitan, which has proved of so great service and is now being considerably extended. The newest of the electric railways is that which will soon be completed from Paris to Versailles, starting from the underground station of the Invalides, on the Seine, which is also the terminal of the Orleans road. The completion of the Mendon tunnel, which was a difficult undertaking, will allow the road to be run as far as Versailles. Electric locomotives, of the Thomson-Houston system, are to be used. The current is furnished by the great Moulineaux station, which was erected on the bank of the Seine shortly before the exposition. It contains Westinghouse alternators which will furnish for this purpose three-phase current at 5,500 volts. But as the Invalides-Versailles system follows the usual practice of 500 volts direct current, a number of substations had to be installed for the transformation. These substations are located near the line and feed it at a practically constant voltage, no matter what the load. One of these is at the Paris end, another at Mendon and the third at Viroflay, along the line to Versailles, and each has four groups of transformers of 300 kilowatts capacity each. The rotary converters are fed from these transformers by a step-down of 5,500 to 330 volts and the converters furnished 500 volts direct current. The difficulties encountered in the Mendon tunnel have delayed the work of the road. The tunnel passes through strata of loose sand, which kept pouring into the tunnel as fast as it was cleared away; finally, however, a special device was adopted, by which the work could be continued, but the progress became much slower than in the ordinary case. Now that the tunnel is completed there is no doubt that the road will soon be in working order.

An interesting apparatus has been invented by F. J. Lothammer in which he proposes to vaporize water by the direct combustion of hydrocarbon gas and to utilize the total product to drive a piston engine. In this way he expects to secure some of the advantages of the gas motor. The latter are more efficient than the steam engine, and are easier to handle, besides consuming nothing when idle. On the contrary, they are noisier and less elastic, also less regular than the steam engine. Their increased efficiency is, of course, due to the fact that the combustion is utilized in a more direct manner. To overcome the drawbacks due to the explosion of the gas, a form of a "combustion motor" has been proposed, in which the fluid is made to burn gradually, but hitherto without success. The inventor claims to have solved the problem by causing the combustion of hydrocarbon fluids or gases under pressure in an enclosed space. The combustion is brought about in a specially designed closed chamber so that the products, at a high temperature, are in the presence of finely divided water. The water becomes vaporized while the gaseous products are cooled. There results a mixture of water vapor, carbonic acid gas and nitrogen under pressure, at a temperature sufficient to be used in a thermic machine, but low enough not to injure the various parts of the apparatus. The "bifluid" is used in a motor which does not differ much from a steam engine. In fact, the "bifluid" generator is only a form of steam generator in which the combustion of the fuel takes place inside the boiler itself, and the products of combustion assist the steam in the engine. The increased efficiency of such a system is at once apparent; in fact, it adds the efficiency of the gas motor to the general good working of the steam engine. The essential features of the device, shown in the diagram, consist of a triple reservoir on the left, containing water, liquid hydrocarbon and air under pressure, with their appropriate pipes and valves. The air and the hydrocarbon are led by separate pipes to a special burner working under pressure, placed below and to the left of the "boiler" proper, which is a closed chamber containing a series of shelves over which the water trickles from the top of the apparatus. The products of combustion at a high temperature pass over the water and vaporize it. The "bifluid" formed by the gases and the steam passes out at the top by a pipe leading to the engine. It, of course, remains to be seen whether the inventor is able to make such a device work in a practical manner, but at any rate the principle involved is one which is worth considering.



THE LOTHAMMER APPARATUS FOR VAPORIZING WATER BY DIRECT COMBUSTION OF HYDROCARBON GAS.

The use of alcohol as a source of energy is developing rapidly in France, and if the present progress continues, it will not be long before there are as many motors driven by alcohol as by gasoline. The small petrol motor was designed originally for the automobile, but the manufacturers soon saw that it was well adapted to be used as a fixed motor, with only a few changes. Another type comes from the gas motor, which is an older form. The gas motor of the "Otto" and similar types has for some time past been adopted to run with gasoline, and many of them are now using alcohol instead. Since it was found a few years ago that alcohol could be used as a motive power as well as gasoline, the subject awakened great interest in France, as here was an opportunity to use a home product, obtained from the distillation of beets instead of the imported gasoline. The Minister of Agriculture instituted a number of competitive tests and expositions to encourage the home industry, and the last alcohol show held at Paris brought out a good number of automobiles and fixed motors, all using alcohol. The engraving shows a typical generating set in which a Falaix motor is coupled to a ten-horse-power dynamo. This forms a compact group, which is self-contained, and would present decided advantages over steam or even the gas engine. A portable set of this kind is especially convenient for many purposes.



FALAIX ALCOHOL MOTOR AND DIRECT-CURRENT DYNAMO AT PARIS ALCOHOL SHOW.

In view of the results of the last competitive tests and the alcohol show there is no doubt that the alcohol motor is now a practical success, and its extensive use, in France at least, is only a matter of time, and also of the fiscal tax upon alcohol, which enters into the question. At present a mixture of alcohol and gasoline in equal proportions is used, although some motors run with pure alcohol. The explosive mixture is formed in about the same way as for gasoline, generally by charging a current of air with alcohol vapor by means of an atomizer. The same alcohol vapor is now being used with an incandescent burner of the Welsbach type for lighting, and the great Salle des Fêtes was full of lamps of this kind. The golden-yellow hue obtained in many cases will make this lamp a formidable competitor of the incandescent lamp as to quality of light, which has been one of the strong points in favor of the latter. Among the automobiles using alcohol was a novel alcohol-electric type devised by M. Krieger, a prominent constructor. In the ordinary type of Krieger electromobile the front wheels are driven independent of each other by a small four-pole motor attached near their inner side, which works the wheel by a gearing. To this arrangement M. Krieger has now added a small generating group in the rear of the vehicle, consisting of a De Dion five-horse-power gasoline motor driving a small four-pole dynamo of 2,000 watts. The generating set works continuously and keeps the accumulators charged. In ordinary cases the motor gives the energy for the automobile and the batteries, but when an extra amount of power is required, as in mounting grades, the batteries are called upon to furnish current for the electric motors. Besides, when the vehicle runs down grade the dynamo acts alone to charge the batteries, with a consequent saving of energy. The generating group uses one litre of carbonated alcohol for one kilowatt-hour for the dynamo, and weighs only 350 pounds, or one-tenth the weight of the vehicle. The distance which may be covered by the electromobile is thus considerably increased, and it becomes practicable for long tours without having to stop for recharging. It is not claimed to be specially economical to operate, but has the advantages which the electromobile possesses, namely, a light and silent running and ease of manœuvre. In case of a breakdown to the gasoline or alcohol motor the electric system may be used, and *vice versa,* thus lessening to a great degree the danger of remaining *en panne,* as the French say. This interesting system will be described and illustrated in a subsequent article, as well as another petrol-electric type, the Lohner-Porsche, the latter differing radically from the preceding in the fact that the electric outfit is used entirely as a transmission device from the petrol motor to the wheels, and as the latter furnishes all the energy, no batteries are used. The motor in the rear drives a six-pole dynamo. The front wheels each carry a circular motor which forms, in fact, the hub of the wheel, being about eighteen inches in diameter. By means of a controller the current and consequently the speed can be regulated with ease, and the transmission is much more flexible than by the usual mechanical devices.

A turbine plant which is to be erected in Austria will utilize the water power of the Save, between Zurschenwassern and Tazen. A syndicate has lately been formed for this purpose at Leybach. The energy will be distributed over the surrounding district in which there is at present considerable industry. A dam is to be constructed across the Save at the first-named locality and the water will be taken off by a canal 3,000 feet long leading along the left bank of the river. The turbine station will be installed near Tazen. In this way a fall of about thirty feet (maximum) will be obtained, from which it is expected to obtain 3,000 horse-power. The syndicate expects to obtain a concession of ninety years for the plant and the cost will be about half a million.

C. L. DURAND.

Paris, June 24.

News from Great Britain.

(By Our Special Correspondent.)

THE preliminary decision come to by the House of Lords Committee upon tube railways reported in my last notes has not been materially affected by the final result given this week, *viz.*, that Mr. Morgan obtains possession of an absolutely new line across London from the west to northeast, and that Mr. Yerkes's endeavors to secure extensions to the lines already in his hands, which would have enabled him to have beaten his rival, have not been successful. But whereas Mr. Morgan has so far only the one line under his control, Mr. Yerkes has bought up quite a number of authorized, but not yet constructed, tubes which, working in conjunction with the Metropolitan District Railway Company, soon to be electrified—power being supplied to all his railways from a 50,000-kilowatt power-house at Chelsea—will provide cheap and rapid transit over London in all directions. An innovation this year, also, has been the sanctioning of a number of electric railways on the surface, of which we have not a sample in London, as distinguished from tramways. Another matter which has somewhat astonished promoters this year, too, has been the searching enquiry made by the committee into the arrangements for providing the capital, and since the advent of the American millionaires, with their stock of funds, very few lines depending upon public subscription have found Parliamentary favor. This is a not altogether unmixed blessing, as we have now quite a number of such tube railways authorized some years ago still awaiting construction owing to want of capital. Some of these are included in the batch secured by Mr. Yerkes's underground railway company, recently formed, and those that are not have been seeking an extension of time in which to build. A misunderstanding appears to have arisen in some quarters as to the proposal to light the tunnels. This will be in addition to lighting the trains. The lights in the tunnel will not be always alight.

Electricity supply in Manchester is leaping ahead with bounds, and the equipment of this town in this respect is little inferior to the huge system in Glasgow. Last week the large Stuart street station, at Manchester, was formally opened, and these brief particulars will show the trend of opinions of our English experts. The current will be generated at 6,500 volts, three-phase, fifty-cycle, and transmitted to ten substations where it will be converted by synchronous motor-generators to 500 volts for traction and 240 volts for lighting and power. The opening ceremony was performed by the Lord Mayor, who started up the one completed 2,500-horse-power set, of which, under the supervision of the consulting engineer, Dr. A. B. W. Kennedy, there will be six eventually. The cost of this installation will be £492,000. In addition to this, however, a further equipment for the same station has been designed by the resident engineer, Mr. Metzger, consisting of 5,000-horse-power generators, which scheme will cost another £450,000, and the cost of the land, in connection with the whole installation, has been some £25,000. It was only in March, 1901, that the scheme in its final form was passed, and with the rapidly increasing electric tramway mileage of the city no time was wasted in pushing the work forward. When completed it will be one of the largest power-houses in the United Kingdom.

I have mentioned at various times the progress of the work of equipping St. Paul's Cathedral with the electric light, a result of the beneficence of Mr. Pierpont Morgan. The installation was put into operation, so far as the nave, chancel, dome and crypts are concerned, at Whitsuntide for the first time. To an extent the work has been an extraordinary one inasmuch as it has involved the drilling of stone walls, for the reception of the wires, which are nearly 200 years old. Connection is made to the mains of the two city supply companies, a piece of commendable foresight. In fact, by means of a double set of circuits alternate lamps are fed by either company. The system of distribution is a two-wire one at 200 volts.

In the days of the London Electric Cab Company, which it will probably be remembered had a very short existence somewhere about the year 1898, the British postal authorities utilized an electric mail van which was manufactured on the principle adopted by the cab company, but this particular mail cart appears to have disappeared contemporaneously with the company. Just recently, however, the Post Office has put into service another such cart, but which has been constructed by Mr. Carl Oppermann, of London, and fitted with a set of accumulators which has been subjected to severe trials in the matter of capacity and efficiency. Seen in the street this car is a striking contrast to the noisy and odorous cars to which London is fast becoming accustomed.

With the near approach of the coronation festivities outside illumination work is being rapidly proceeded with, and so far as London itself is concerned, it is impossible to ignore the large number of fittings for gas. One readily accepted reason went the rounds to the effect that the London electric lighting companies refused to guarantee a supply, but this was very quickly contradicted, and having in mind the enormous amount of labor involved in connection with the actual lighting of gas illuminations we are still left wondering. In the provinces much energy is being displayed, and at Huddersfield, as well as a few other towns, free current is to be given for display purposes.

It is announced that Mr. Behr, in connection with his express mono-rail line between Liverpool and Manchester, will not go to the public for the necessary capital, but will endeavor to finance the scheme himself. Whether Mr. Behr has taken this step as a result of similar unsuccessful efforts made on behalf of London tube railways I do not know, but it is astonishing how chary the British public are of putting money into electric traction enterprises.

The first accident yet recorded on the surface contact system of tramways in Wolverhampton happened last week when a horse was killed through one of the studs remaining charged after the car had passed. Other small shocks have also been noticed, but they have not been put down to this cause. In connection with surface contact systems, the Beery corporation, in Lancashire, has entered into an arrangement whereby the Johnson-Lundell Electric Traction Company is to lay down an experimental section on its system.

The Tramways and Light Railways Exhibition in London, the first of which was held in 1900, will be again opened on July 1, and a splendid entry of ex-

hibitors has been secured. As on the previous occasion the Westinghouse company has rented a tremendous space, and its exhibit will run the full length of the exhibition building. I hope to say something more about this later on.

Lord and Lady Kelvin, on their return home from America, spoke in high terms of their reception.

The Institution of Electrical Engineers, whose good work in the interest of the industry I mentioned in my last notes, has good reason to be satisfied with its labors. The objection to the inclusion of generating stations under the Factories Act has led to a modification of certain provisions of that act when applied to these buildings, and *apropos* of the outburst of indignation against legislation as applied to the electrical industry generally, the government has consented to receive a deputation which will place the whole matter before it. The agitation raised by the Institution has received unusual attention and good should result from the work of the deputation above referred to.

The effort to maintain street lighting at Shipley by means of Nernst lamps did not meet with the success anticipated, and they have been removed.

Another project similar to the one for a railway from London to Brighton, which was knocked out this session on a technical point, is for an electric railway from London to Dover, a distance of over seventy miles, which it is proposed to cover in fifty minutes. The accommodation at present is too bad for words, and no one would regret it if a bill was introduced next session.

The American Exhibition, which has been fairly extensively advertised over here, opened on Saturday, but was a disappointment, both from a general and an electrical point of view, but as is not unusual with exhibitions at the Crystal Palace, a week or so may witness a great improvement all around.

Professor Carus-Wilson, who a week or so ago read a paper before the Institution of Electrical Engineers on the "Electrification of Steam Railways in Italy," drew comparisons between the methods adopted out there and the possible result of a similar experiment on any English main steam lines. But the outstanding feature of the discussion which followed was the gloomy attitude taken up by some traffic managers as to the impossibility of the electrification of steam railways here to any great extent, a view partly shared by the president, Mr. W. E. Langdon, who is electrical engineer to the Midland Railway Company.

The daily papers of the municipal persuasion, guided by persons possessing sufficient engineering capability to influence an opinion, have lately been delating with considerable energy against the aims and operations of the British Electric Traction Company, a body which for some years now has been steadily securing controlling interests in numerous steam and horse tramway concerns with the view of ultimately working them by means of electric traction, in addition to obtaining powers to construct new lines. The scope of the British Electric Traction Company, however, does not end here, for closely allied to it—indeed promoted by it—are the majority of the electrical power distribution schemes which have sprung into existence during the past year or two. In all this, the votaries of municipal trading foresee a terrible finality akin to millionaire Morgan's trusts and combinations, and perhaps, for all one can see at the moment, this opinion may not be very wide of the mark. But in Great Britain we have to deal with peculiar circumstances. In spite of the municipalizing tendencies of the larger towns, such as Glasgow, Manchester, Liverpool, etc., and the rapidity with which such tendencies are put into practical shape, a peculiarly stubborn dog-in-the-manger policy pervades numerous local governing bodies in respect of the domain of industry now being entered by the British Electric Traction Company, and presuming that this company has not appeared on the scene, as our municipal friends would seem to desire, we may take to ourselves the consolation that existing conditions, such as horse and steam tramways, gas lighting and steam power driving for factories, etc., would continue to prevail until no one knows when. What the British Electric Traction Company and its offshoots effect is this: To all intents and purposes they buy up, say, a steam tramway by the acquisition of a majority of the shares and in due course convert it to electric tractions. Numerous such lines have so been dealt with up to date. When this mode of procedure was first commenced no one took particular notice of it—certainly not our political municipal advocates—but in course of time the list of tramways coming into the hands of the company in this way has grown to such formidable dimensions that the opponents of private joint stock enterprise on a large scale have been seized with an alarm which has at last found its vent in the more antagonistic of the daily newspapers. Everyone sees disadvantages in things of this nature, but these drawbacks must be viewed with calmness in the full knowledge that an industrial and commercial progress is being made thereby which would otherwise not take place, for if left to the local authorities no effort would be made, and if left to the existing companies no money would be forthcoming. Tramways, in the opinion of many, are one of those things which should be in the hands of the municipality, for the reason that every one in the district utilizes them and helps to make them a financial success, but if the said municipalities lack the necessary enterprise or funds to give an efficient and up-to-date means of locomotion, the cause of municipal trading is not strengthened by strenuous efforts to prevent private individuals taking the risk.

Mr. A. P. Trotter, the electrical adviser to the Board of Trade, persists in bringing before the public the harmlessness of the electrical pressures commonly employed on street electric tramways, and in personally demonstrating the nugatory effect under normal conditions of the human system is probably accomplishing more in the cause of electric traction by dissipating the undoubted public prejudice which occasionally finds its way to the surface than anything else is likely to do. Following on his practical and personal demonstrations at the Institution of Electrical Engineers some months ago, he performed similarly amusing feats upon a length of third-rail, 500-volt conductor, attired with the conventional dress suit at the annual convention of the Institute of Civil Engineers last week.

An unfortunate and lamentable fire occurred a few days ago at the stores of the General Electric Company in Queen Victoria street, whereby some ten persons, mostly very young girls, were burnt to death and a large number of others injured by jumping from the sixth floor windows. Stocked with a large quantity of material for illumination purposes, as the stores were, the fire spread with amazing rapidity, and the lack of a sufficiently long fire escape at the commencement leaves a sad death roll. A. W.

London, June 21.

NOTES ON THE THEORY OF THE SYNCHRONOUS MOTOR, WITH SPECIAL REFERENCE TO THE PHENOMENON OF SURGING.

BY CHARLES PROTEUS STEINMETZ.

I.

While an induction motor at constant impressed voltage is fully determined as regards to current, power factor, efficiency, etc., by one independent variable, the load or output, in the synchronous motor two independent variables exist, load and field excitation. That is, at constant impressed voltage the current, power factor, etc., of a synchronous motor can at the same power output be varied over a wide range by varying the field excitation, that is, the counter electro-motive force or "nominal induced electro-motive force." Hence the synchronous motor can be utilized to fulfill two independent functions, to carry a certain load and to produce a certain wattless current, lagging by under-excitation, leading by over-excitation. Synchronous motors are, therefore, to a considerable extent used to control the phase relation and thereby the voltage, in addition to producing mechanical power.

The same applies to synchronous converters.

With given impressed electro-motive force, field excitation or counter electro-motive force corresponding thereto, and load, determine by the usual theory all the quantities of the synchronous motor, as current, power factor, etc. Thus, if in diagram Fig. 1, $\overline{O\,E} = e$ = electro-motive force consumed by the counter electro-motive force of the synchronous motor as corresponding to its field excitation, and if P_0 = output of motor (exclusive of friction and core loss and, if the exciter is driven by the motor, power consumed by the exciter), $i_1 = P_0/e$ = energy component of current, represented by $\overline{O\,I_1}$, and the current vector therefore must terminate on a line i perpendicular to $\overline{O\,I_1}$. If, then, r = resistance and x = reactance of the circuit between counter electro-motive force e and impressed electro-motive force e_0, $\overline{O\,E}_r = i_1 r$ = electro-motive force consumed by resistance, $O\,E_x = i_1 x$ = electro-motive force consumed by reactance of the energy current i_1, hence $O\,E'_1$ = electro-motive force consumed by impedance of the energy current i_1, and the impedance voltage of the total current lies on the perpendicular e^1 on $\overline{O\,E_1}^1$. Producing $\overline{O\,E_1} = \overline{O\,E}$, and drawing an arc with the impressed electro-motive force e_0 as radius and E_1 as centre, the point of intersection with e_1 gives the impedance voltage $\overline{O\,E}^1$, and corresponding thereto the current $\overline{O\,I} = i$; and completing the parallelogram $O\,E\,E_0\,E^1$ gives the impressed electro-motive force $\overline{O\,E_0}$.

Hence, by impressed electro-motive force e_0, counter electro-motive force e, and load P_0, the polar diagram is

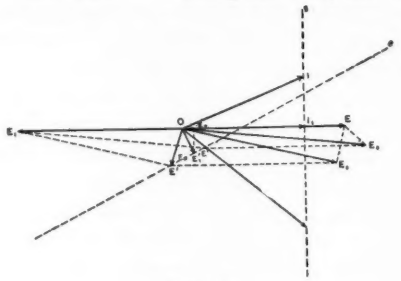


FIG. 1.

determined, and thereby the vectors O I = current $\overline{O\,E_0}$ = impressed electro-motive force, O E = counter electro-motive force, and their phase relation.

Or, in symbolic representation, let:

$E_0 = e_0^1 + j\,e_0''$ = impressed electro-motive force; $e_0 = \sqrt{e_0'^2 + e_0''^2}$ (1)

$E = e' + j\,e''$ = electro-motive force consumed by counter electro-motive force; $e = \sqrt{e'^2 + e''^2}$ (2)

$I = i$ = current, assumed as zero vector.

$Z = r - j\,x$ = impedance of circuit between e_0 and e.

Z is the synchronous impedance of the motor, if e_0 is its terminal voltage. It is the impedance of transmission line with transformers and motor, if e_0 is terminal voltage of generator, and Z is synchronous

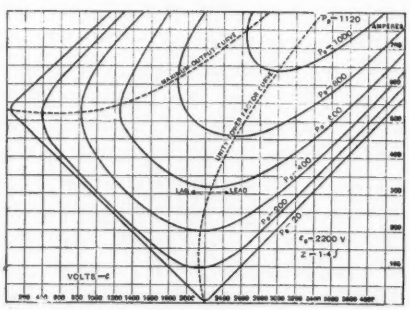


FIG. 2.

impedance of motor and generator, plus impedance of line and transformer, if e_0 is the nominal induced electro-motive force of the generator (corresponding to its field excitation).

It is, then:

$$E_0 = E + i\,Z \qquad (3)$$

or:

$$e_0' + j\,e_0'' = e' + j\,e'' + i\,r - j\,i\,x \qquad (4)$$

and, resolved:

$$\left\{\begin{aligned} e_0' &= e_0 + i\,r \qquad (5)\\ e_0'' &= e'' - i\,x \qquad (6)\end{aligned}\right.$$

The power output of the motor (inclusive of friction and core loss, and if the exciter is driven by the motor, power consumed by exciter) is current times energy component of induced electro-motive force, or:

$$P_0 = e'\,i \qquad (7)$$

Hence, the calculation of the motor, from power output P_0, occurs by the equation:

Chosen: i = current.

$$\begin{aligned} (7)\quad e' &= P_0/i\\ (5)\quad e_0' &= e' + i\,r\\ (1)\quad e_0'' &= \pm\sqrt{e_0^2 - e_0'^2}\\ (6)\quad e'' &= e_0'' + i\,x\\ (2)\quad e &= \sqrt{e'^2 + e''^2}\end{aligned}$$

That is, at given power P_0, to every value of current i correspond two values of the counter electro-motive force e (and hence the field excitation).

For illustration are plotted in Fig. 2, curves giving the current i as function of the counter electro-motive force e, at constant power P_0, the so-called "synchronous motor phase characteristics," for the values:

e_0 = 2,200 volts

$Z = 1 - 4\,j$ ohms

and

P_0 = 20, 200, 400, 600, 800, 1,000 kilowatts output.

The five equations of the synchronous motor:

$$\begin{aligned} (1)\quad e_0^2 &= e_0'^2 + e_0''^2\\ (2)\quad e^2 &= e'^2 + e''^2\\ (7)\quad P_0 &= e'\,i\\ (5)\quad e_0' &= e' + i\,r\\ (6)\quad e_0'' &= e'' - i\,x\end{aligned}$$

determine the five quantities: e_0', e_0'', e_0', e_0'', e, as functions of P_0 and i.

The condition of zero phase displacement, or unity power factor at the impressed electro-motive force e_0, is:

$$e_0'' = 0$$

hence: $e_0' = e_0$, and

$$\begin{aligned} (6)\quad e'' &= i\,x\\ (5)\quad e' &= e_0 - i\,r\end{aligned}$$

hence:

$$e^2 = (e^0 - i\,r)^2 + i^2\,x^2 \qquad (8)$$

a quadratic equation, the hyperbola of unity power factor, shown as dotted line in Fig. 2.

In this case, the power is found by substituting $e' = e_0 - i\,r$ in $P_0 = e'\,i$, as:

$$P_0 = e_0\,i - i^2\,r \qquad (9)$$

or:

$$i = \frac{e_0}{2\,r}\left\{1 \pm \sqrt{1 - \frac{4\,r\,P_0}{e_0^2}}\right\} \qquad (10)$$

As maximum output of the synchronous motor follows herefrom:

$$\sqrt{1 - \frac{4\,r\,P_0}{e_0^2}} = 0$$

in above instance:

A paper presented at the nineteenth annual convention of the American Institute of Electrical Engineers Great Barrington, Mass., June 18 to 21, 1902.

P_0 = 1,210 kilowatts at: i = 1,100 amperes.

The curve of unity power factor (8) divides the synchronous motor phase characteristics into two sections, one, for lower e, with lagging, the other with leading current.

The study of these "phase characteristics," Fig. 2, gives the best insight into the behavior of the synchronous motor under conditions of steady operation.

Of special interest are the "load curves" of the synchronous motor, or curves giving, at constant excitation: e = constant, the current, power factor, efficiency and apparent efficiency as function of the load or output P = P_0 — (friction + core loss + excitation). Such load curves are represented in Figs. 3, 4, 5, 6, 7 for e = 1,600, 2,800, 2,000, 2,400, 2,180 volts. They are derived from Fig. 2 as the intersection of the curves P_0 = constant with the vertical lines e = constant.

Hence, while an induction motor has one load curve only, a synchronous motor has an infinite series of load curves, depending upon the value of e.

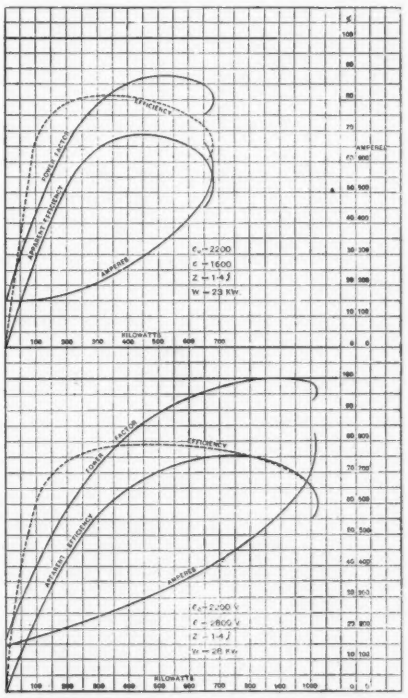
As seen, for low values of e (e = 1,600 under excitation, Fig. 3), the load curves are similar to those of an induction motor. The current is lagging, the power factor rises from a low initial value to a maximum, and then falls again. With increasing excitation (e = 2,000, Fig. 5) the power factor curve rises to values beyond those available in induction motors, approaches and ultimately touches unity, and with still higher excitation (e = 2,180, Fig. 7) two points of unity power factor exist, at P=20 and P=450 kilowatts output, which are separated by a range with leading current, while at very low and very high load the current is lagging. The first point of unity power factor moves toward P = O, and then disappears, that is, the current becomes leading already at no load, and the second point of unity power factor moves with increasing excitation toward higher loads, from P = 450 kilowatts at e = 2,180 in Fig. 7, to P = 700 kilowatts at e = 2,400 and P = 900 kilowatts at e = 2,800, while the power factor and thereby the apparent efficiency decreases at light loads. The maximum output increases with the increase of excitation and almost proportionally thereto.

It is interesting that at e = 2,180, the power factor is practically unity over the whole range of load up to near the maximum output. It is shown once more in Fig. 7 with increased scale of the ordinates. A synchronous motor at constant excitation can, therefore, give practically unity power factor for all loads.

The resistance r = 1 ohm is assumed so as to represent a synchronous motor inclusive of transmission line, with about nine per cent loss of energy in the line at 400 kilowatts output.

The friction and core loss are assumed as 20 kilowatts, the excitation as 4 kilowatts at e = 2,000.

Considering the intersections of a horizontal line with the constant power curves of Fig. 2, gives the characteristic curves of the synchronous motor when operating on constant current. Such curves are shown for i = 300 in Fig. 8. They illustrate that at the same impressed voltage with the same current input the power output of the synchronous motor can vary over a wide range, and also that for each



FIGS. 3 AND 4.

value of power output two points exist, one with lagging, the other with leading current.

As regards phase characteristics and load characteristics, the same applies to the synchronous converter as to the synchronous motor, except that in the former the continuous current output affords a means of automatically varying the excitation with the load.

II.

In the preceding theory of the synchronous motor the assumption has been made that the mechanical output of the motor equals the power developed by it. This is the case only if the motor runs at constant speed. If, however, it accelerates, the power input is greater, if it decelerates, less than the power output, by the power stored in and returned by the momentum. Obviously, the motor can neither constantly accelerate nor decelerate, without breaking out of synchronism, since the counter electro-motive force e must remain within a quarter wave of the impressed electro-motive force e_0, assuming the latter as of constant frequency.

If, for instance, at a certain moment the power produced by the motor exceeds the mechanical load (as, for instance, in the moment of throwing off a part of the load), the excess power is consumed by the momentum as acceleration, causing an increase of speed. The result thereof is that the phase of the counter electro-motive force e is not constant, but the vector e (in Fig. 1) moves backward to earlier time, or counter clockwise, at a rate depending upon the momentum. Thereby the current changes and the power developed changes and decreases. As soon as the power produced equals the load, the acceleration ceases, but the vector e still being in motion, due to the increased speed, further reduces the power, causing a retardation and thereby a decrease of speed, at a rate depending upon the mechanical momentum. In this manner a periodic variation of the phase relation between e and e_0, and corresponding variation of speed and current occurs, of an amplitude and period depending upon the circuit conditions and the mechanical momentum.

If the amplitude of this pulsation has a positive decrement, that is, is decreasing, the motor assumes after a while a constant position of e regarding e_0, that is, its speed becomes uniform. If, however, the decrement of the pulsation is negative, an infinitely small pulsation will continuously increase in amplitude, until the motor is thrown out of step, or the decrement becomes zero, by the power consumed by forces opposing the pulsation, as anti-surging devices. If the decrement is zero, a pulsation started at once will continue indefinitely at constant amplitude. This phenomenon, a surging by what may be called electro-mechanical resonance, must be taken into consideration in a complete theory of the synchronous motor.

Let:

$E_0 = e_0$ = impressed electro-motive force, assumed as zero vector.

$E = e(\cos\beta + j \sin\beta)$ = electro-motive force consumed by counter electro-motive force of motor where: β = phase angle between E_0 and E.

Let:

$Z = r - j\,x$, $z = \sqrt{r^2 + x^2}$ = impedance of circuit between E_0 and E, and: $\tan\alpha = x/r$

The current in the system is:

$$I_0 = \frac{e_0 - E}{z} = \frac{e_0 - e\cos\beta - j\, e\sin\beta}{r - j\, x}$$
$$= (1/z)\,\{[e_0\cos\alpha - e\cos(\alpha+\beta)] + j\,[e_0\sin\alpha - e\sin(\alpha+\beta)]\} \quad (11)$$

The power developed by the synchronous motor is:

$$P_0 = [E\ I]^1$$
$$= (e/z)\,\{[\cos\beta\,[e_0\cos\alpha - e\cos(\alpha+\beta)] + \sin\beta\,[e_0\sin\alpha - e\sin(\alpha+\beta)]\}$$
$$= (e/z)\,\{[e_0\cos(\alpha-\beta) - e\cos\alpha]\} \quad (12)$$

If, now, a pulsation of synchronous motor occurs, resulting in a change of the phase relation β between the counter electro-motive force e and the impressed electro-motive force e_0 (the latter being of constant frequency, thus constant phase), by an angle δ, where δ is a periodic function of time, of a frequency very low compared with the impressed frequency, then the phase angle of the counter electro-motive force e is: $\beta + \delta$; and the counter electro-motive force is:

$$E = e\,\{\cos(\beta+\delta) + j\sin(\beta+\delta)\}$$

hence the current:

$$I = (1/z)\,\{[e_0\cos\alpha - e\cos(\alpha+\beta+\delta)] + j\,[e_0\sin\alpha - e\sin(\alpha+\beta+\delta)]\}$$
$$= I_0 + \frac{2e}{z}\sin\frac{\delta}{2}\left\{\sin\left(\alpha+\beta+\frac{\delta}{2}\right) - j\cos\left(\alpha+\beta+\frac{\delta}{2}\right)\right\} \quad (13)$$

the power:

$$P = e/z\,\{e_0\cos(\alpha-\beta\,\delta) - e\cos\alpha\}$$
$$= P_0 + \frac{2\,e\,e_0}{z}\sin\frac{\delta}{2}\sin\left(\alpha-\beta-\frac{\delta}{2}\right) \quad (14)$$

Let now:

v_0 = mean velocity (linear, at radius of gyration) of synchronous machine

s = slip, or decrease of velocity, as fraction of v_0, where s is a (periodic) function of time; hence:

$v = v_0\,(1 - s)$ = actual velocity, at time t.

During the time element dt, the position of the synchronous motor armature regarding the impressed electro-motive force e_0, and thereby the phase angle $\beta + \delta$ of e, changes by:

$$d\,\delta = 2\,\pi\,N\,s\,dt$$
$$= s\,d\,\varphi \quad (15)$$

where:

$\varphi = 2\,\pi\,N\,t$

and:

N = frequency of impressed electro-motive force e_0

Let:

m = mass of revolving machine elements, and

$M_0 = \frac{1}{2}\,m\,v_0^2$ = mean mechanical momentum, reduced to joules or watt-seconds, then the momentum at time t and velocity $v = v_0\,(1 - s)$ is:

$$M = \tfrac{1}{2}\,m\,v_0^2\,(1-s)^2$$

and the change of the momentum during the time element dt is:

$$\frac{d\,M}{dt} = -\,m\,v_0^2\,(1-s)\,\frac{d\,s}{dt}$$

hence, for small values of s:

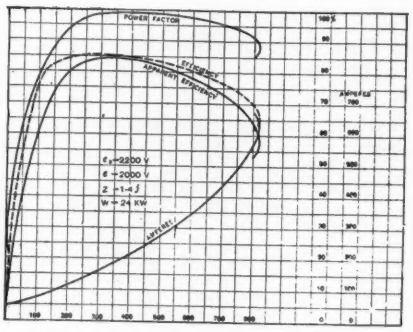


FIG. 5.

$$\frac{d\,M}{dt} = -\,m\,v_0^2\,\frac{ds}{d\varphi}\,\frac{d\varphi}{dt}$$
$$= -\,2\,M_0\,\frac{d\,s}{d\varphi}\,\frac{d\,\varphi}{dt} \quad (16)$$

since:

$(d\varphi/dt) = 2\,\pi\,N$, and from (15):

$s = (d\,\delta/d\varphi)$

$(ds/d\varphi) = (d^2\delta/d\varphi^2)$

it is:

$$(d\,M/dt) = -\,4\,\pi\,N\,M_0\,(d^2\delta/d\varphi^2) \quad (17)$$

Since, as discussed, the change of momentum equals the difference between produced and consumed power, the excess

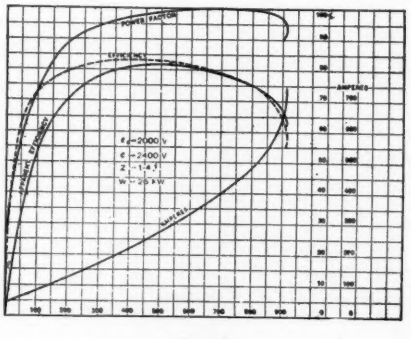


FIG. 6.

of power being converted into momentum, it is:

$$P - P_0 = (d\,M/dt) \quad (18)$$

and, substituting (14) and (17):

$$\frac{e\,e_0}{z}\sin\frac{\delta}{2}\sin\left(\alpha-\beta-\frac{\delta}{2}\right) + \frac{2}{\pi}\,N\,M_0\,\frac{d^2\,\delta}{d\,\varphi^2} = 0 \quad (19)$$

Assuming δ as a small angle, that is, considering only small oscillations, it is:

$\sin(\delta/2) = (\delta/2)$

$\sin[\alpha - \beta - (\delta/2)] = \sin(\alpha - \beta)$

hence, substituted in (18):

$$\frac{e\,e_0}{z}\,\delta\sin(\alpha-\beta) + 4\,\pi\,N\,M_0\,\frac{d^2\,\delta}{d\,\varphi^2} = 0 \quad (20)$$

and, substituting:

$$a = [e\,e_0\sin(\alpha-\beta)]/[4\,\pi\,N\,z\,M_0] \quad (21)$$

it is:

$$a\,\delta + (d^2\,\delta/d\,\varphi^2) = 0 \quad (22)$$

This differential equation is integrated by:

$$\delta = A\,\varepsilon\,C\phi \quad (23)$$

which, substituted in (22) gives:

$$a\,A\,\varepsilon\,C\phi + AC^2\,\varepsilon\,C\phi = 0$$
$$a + C^2 = 0$$
$$C = \pm\sqrt{-a} \quad (24)$$

(1) If $a < 0$, it is:

$$\delta = A_1\,\varepsilon + m\phi + A_2\,\varepsilon - m\phi$$

where

$$m = \sqrt{-a} = \sqrt{\frac{e\,e_0\sin(\beta-\alpha)}{4\,\pi\,N\,z\,M_0}}$$

Since in this case, $\varepsilon + m\phi$ is continually increasing, the synchronous motor is unstable. That is, without oscillation it drops out of step, if $\beta > \alpha$

(2) If $a > 0$, it is, denoting:

$$n = +\sqrt{a} = +\sqrt{\frac{e\,e_0\sin(\alpha-\beta)}{4\,\pi\,N\,z\,M_0}}$$

$$\delta = A_1\,\varepsilon^{+j\,n\,\phi} + A_2\,\varepsilon^{-j\,n\,\phi}$$

or, substituting for $\varepsilon^{+j\,n\,\phi}$ and $\varepsilon^{+j\,n\,\phi}$ the trigonometric functions:

$$\delta = (A_1 + A_2)\cos n\,\varphi + j\,(A_1 - A_2)\sin n\,\varphi$$

or: $\delta = B\cos(n\,\varphi + \gamma)$ (25)

That is, the synchronous motor is in stable equilibrium, when oscillating with a constant amplitude B, depending upon the initial conditions of oscillation, and a period, which for small oscillations gives the frequency of oscillation:

$$N_0 = n\,N$$
$$= \sqrt{\frac{N\,e\,e_0\sin(\alpha-\beta)}{4\,\pi\,N\,z\,M_0}} \quad (26)$$

In the instance given in Part I it is:

$e_0 = 2{,}200$ volts. $Z = 1 - 4\,j$ ohms, or: $z = 4.12$; $\alpha = 76°$.

Let the machine, a 16-polar 60-cycle 400-kilowatt revolving field synchronous motor, have the radius of gyration of 20″, a weight of the revolving part of 6,000 lbs.

The momentum then is: $M_0 = 850{,}000$ joules.

Deriving the angles β, corresponding to given values of output P and excitation e, from the polar diagram, or from the symbolic representation, and substituting in (26), gives the frequency of oscillation:

P = 0:

e = 1600	volts	β = — 2°	N_0 = 2.17	cycles, or	130	periods	per	minute.
2180	"	+ 3°	2.50	"	150	"	"	"
2800	"	+ 5°	2.85	"	169	"	"	"

P = 400 kilowatts:

e = 1600	volts	β = 33°	N_0 = 1.90	cycles, or	114	periods	per	minute.
2180	"	21°	2.31	"	139	"	"	"
2800	"	22°	2.61	"	154	"	"	"

As seen, the frequency of oscillation does not vary much with the load and with the excitation. It slightly decreases with increase of load, and it increases with increase of excitation.

In this instance, only the momentum of the motor has been considered, as would be the case for instance in a synchronous converter.

In a direct connected motor-generator set, assuming the momentum of the direct current generator armature equal to sixty per cent of the momentum of the synchronous motor, the total momentum is M_0 = 1,360,000 joules, hence, at no load:

P = 0

e = 1,600 volts: N_0 = 1.72 cycles, or 103 periods per minute.
1.98 " 119 " " "
1.23 " 134 " " "

III.

In the preceding discussion of the surging of the synchronous machines, the assumption has been made, that the mechanical power consumed by the load is constant, and that no damping or anti-surging devices were used.

The mechanical power consumed by the load varies, however, more or less with the speed, approximately proportional to the speed if the motor directly drives mechanical apparatus, as pumps, etc., and at a higher power of the speed if driving direct current generators, or as synchronous converter, especially when in parallel, with other direct current generators. Assuming, then, in the general case the mechanical power consumed by the load to vary, within the narrow range of speed variation considered during the oscillation, as the p *th* power of the speed, in the preceding equation instead of P_0 is to be substituted: $P_0(1-s)^p = P_0(1-p\,s)$.

If anti-surging devices are used, and even without these in machines in which eddy currents can be induced by the oscillation of slip, in solid field poles, etc., a torque is produced more or less proportional to the deviation of speed from synchronism. This power assumes the form $P_1 = c^2 s$, where c^2 is a function of the conductivity of the eddy current circuit and the intensity of the magnetic field of the machine; c^2 is the power which would be required to drive the magnetic field of the motor through the circuits of the anti-surging device at full frequency, if the same relative proportions could be retained at full frequency as at the frequency of slip s. That is, P_1 is the power produced by the motor as induction machine at slip s. Instead of P, the power generated by the motor, has to be substituted then in the preceding equations the value $P + P_1$.

The equation (18) then assumes the form:

$$P + P_1 - P_0(1 - p\,s) = (dM/dt)$$

or:

$$(P - P_0) + (P_1 + p\,P_0 s) = (dM/dt) \qquad (27)$$

or, substituting (17) and (14)

$$(2\,e\,e_0/z)\sin(\delta/2)\sin[\alpha - \beta\,(\delta/2)] + (c^2 + p\,P_0)(d\,\delta/d\,\varphi) + 4\,\pi\,N\,M_0\,(d^2\delta/d\varphi^2) = 0 \qquad (28)$$

and, for small values of δ:

$$a\,\delta + 2\,b\,(d\,\delta/d\,\varphi) + (d^2\delta/d\,\varphi^2) = 0 \qquad (29)$$

$$a = [e\,e_0 \sin(\alpha - \beta)]/[4\,\pi\,N\,z\,M_0]$$
$$b = [c^2 + p\,P_0[/[8\,\pi\,N\,M_0)]] \qquad (30)$$

Of these two terms b represents the consumption, a the oscillation of energy by the pulsation of phase angle β; b and a thus have a similar relation as resistance and reactance in alternating current circuits, or in the discharge of condensers; a is the same term as in Part II.

Differential equation (29) is integrated by:

which, substituted in (29) gives:

$$\delta = A\,\epsilon^{C\phi} \qquad (31)$$

$$a\,A\,\epsilon^{C\phi} + 2\,b\,C\,A\,\epsilon^{C\phi} + C^2\,A\,\epsilon^{C\phi} = 0$$

$$a + 2\,b\,C + C^2 = 0$$

which equation has the two roots:

$$C_1 = -b + \sqrt{b^2 - a}$$
$$C_2 = -b - \sqrt{b^2 - a} \qquad (32)$$

(1) If: $a < 0$, or negative, that is, $\beta < \alpha$, C_1 is positive and C_2 negative, and the term with C_1 is continuously increasing, that is, the synchronous motor is unstable, and, without oscillation, drifts out of step.

(2) If: $0 < a < b^2$, or a positive, and b^2 larger than a (that is, the energy consuming term very large), C^1 and C^2 are both negative, and by substituting: $+\sqrt{b^2 - a} = f$, it is:

$$C_1 = -(b - f), \quad C_2 = -(b + f)$$

hence:

$$\delta = A_1\,\epsilon^{-(b-f)\phi} + A_2\,\epsilon^{-(b+f)\phi} \qquad (33)$$

That is, the motor steadies down to its mean position logarithmically, or without any oscillation.

$$b^2 < a$$

or:

$$[(c^2 + p\,P_0)^2]/[16\,\pi\,NM_0] < [e\,e_0 \sin(\alpha - \beta)]/z \qquad (34)$$

is the condition under which no oscillation can occur.

As seen, the left side of (34) contains only mechanical, the right side only electrical terms.

(3) $a > b^2$.

In this case, $\sqrt{b^2 - a}$ is imaginary, and, substituting:

$$g = \sqrt{a - b^2}$$

it is:

$$C_1 = -b + j\,g$$
$$C_2 = -b - j\,g$$

hence:

$$\delta = \epsilon^{-b\phi}[A_1\,\epsilon^{+jg\phi} + A_2\,\epsilon^{-jg\phi}]$$

and, substituting the trigonometric for the exponential functions, gives ultimately:

$$\delta = B\,\epsilon^{-b\phi}\cos(g\,\varphi + \delta) \qquad (35)$$

That is, the motor steadies down with an oscillation of period:

$$N_0 = g\,N =$$

$$\sqrt{\frac{N\,e\,e_0 \sin(\alpha - \beta)}{4\,\pi\,z\,M_0} - \frac{(c^2 + p\,P_0)^2}{64\,\pi^2\,M_0^2]}} \qquad (36)$$

and decrement or attenuation constant.

$$b = [c^2 + p\,P_0]/[8\,\pi\,NM_0]$$

IV.

It follows, however, that under the conditions considered, a cumulative surging, or an oscillation with continuously increasing amplitude, can not occur, but that a synchronous motor, when displaced in phase from its mean position, returns thereto either aperiodically, if $b^2 > a$, or with an oscillation of vanishing amplitude, if $b^2 < a$. At the worst, it may oscillate with constant amplitude, if $b = 0$.

Cumulative surging can, therefore, occur only if in the differential equation,

(29)

$$a\,\delta + 2\,b\,[d\,\delta]/[d\,\varphi] + [d^2\,\delta]/[d\,\varphi^2] = 0$$

the coefficient b is negative.

Since c^2, representing the induction motor torque of the damping device, etc., is positive, and $p\,P_0$ is also positive (p being the exponent of power variation with

speed), this presupposes the existence of a third and negative term, $(-h^2/8\pi NM_0)$, in b:

$$b = [c^2 + p\,P_0 - h^2]/[8\,\pi\,NM_0] \quad (39)$$

This negative term represents a power:

$$P_2 = -h^2\,s \quad (38)$$

that is, a retarding torque during slow speed, or increasing β, and accelerating torque during high speed, or decreasing β.

The source of this torque may be found external to the motor, or internal, in its magnetic circuit.

External sources of negative P_2 may be, for instance, the magnetic field of a self-exciting direct current generator, driven by the synchronous motor. With decrease of speed, this field decreases, due to the decrease of generated voltage, and increases with increase of speed. This change of field strength, however, lags behind the exciting voltage and thus speed, that is, during decrease of speed the output is greater than during increase of speed. If this direct current generator is the exciter of the synchronous motor, the effect may be intensified.

The change of power input into the synchronous motor, with change of speed, may cause the governor to act on the prime mover driving the generator, which supplies power to the motor, and the lag of the governor behind the change of output gives a pulsation of the generator frequency, of e_0, which acts like a negative power P_2. The pulsation of impressed voltage, caused by the pulsation of β, may give rise to a negative P_2 also.

An internal cause of a negative term P_2 is found in the lag of the synchronous motor field behind the resultant magneto-motive force. In the preceding discussion, e is the "nominal induced electro motive force" of the synchronous machine, corresponding to the field excitation. The actual magnetic flux of the machine, however, does not correspond to e, and thus to the field excitation, but corresponds to the resultant magneto-motive force of field excitation and armature reaction, which latter varies in intensity and in phase during the oscillation of β. Hence, while e is constant, the magnetic flux is not constant, but pulsates with the oscillations of the machine. This pulsation of the magnetic flux lags behind the pulsation of magneto-motive force, and thereby gives rise to a term in b equation (37). If P_0, β, e e_0, Z are such that a retardation of the motor increases the demagnetizing force of the armature reaction, a negative term P_2 appears, otherwise a positive term.

P_2 in this case is the energy consumed by the magnetic cycle of the machine at full frequency, assuming the cycle at full frequency as the same as at frequency of slip s.

Or inversely, e may be said to pulsate, due to the pulsation of armature reaction, with the same frequency as β, but with a phase, which may either be lagging or

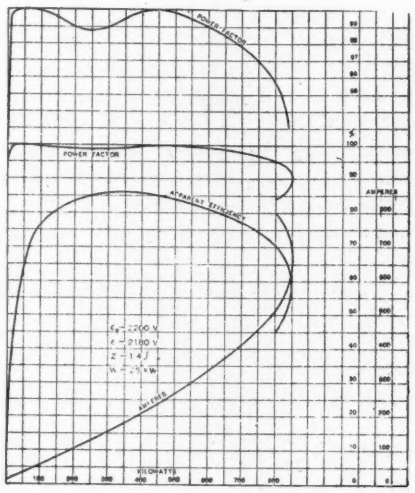


FIG. 7.

leading. Lagging of the pulsation of e causes a negative, leading a positive P_2.

P_2, therefore, represents the power due to the pulsation of e caused by the pulsation of the armature reaction.

Any appliance increasing the area of the magnetic cycle of pulsation, as short-

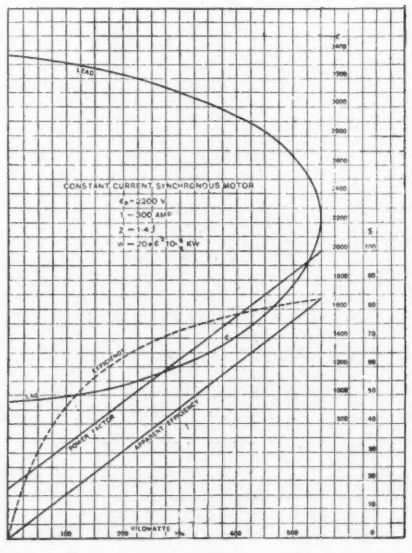


FIG. 8.

circuits around the field poles, therefore, increases the steadiness of a steady and increases the unsteadiness of an unsteady synchronous motor.

In self-exciting synchronous converters, the pulsation of e is intensified by the pulsation of direct current voltage caused thereby, and hence of excitation.

Introducing now the term $P_2 = -h^2\,s$ into the differential equations of Part III, gives the additional cases:

$b < 0$, or negative, that is:

$$(c^2 + p\,P_0 - h^2)/(8\,\pi\,NM_0) < 0 \quad (39)$$

Hence, denoting:

$$b_1 = -b = (h^2 - c^2 - p\,P_0)/(8\,\pi\,NM_0)$$

gives:

(4) if: $b_1^2 > a$: $f = +\sqrt{b_1^2 - a}$

$$\delta = A_1\,\varepsilon^{+(b_1+f)\phi} + A_2\,\varepsilon^{+(b_1-f)\phi} \quad (40)$$

That is, without oscillation, the motor drifts out of step, in unstable equilibrium.

(5) if: $a > b^2$: $g = \sqrt{a - b_1^2}$

$$\delta = A\,\varepsilon^{+b_1\phi}\cos(g\,\varphi + \delta) \quad (41)$$

That is, the motor oscillates, with constantly increasing amplitude, until it drops out of step. This is the typical case of the cumulative surging by electro-mechanical resonance.

The problem of surging of synchronous machines, and its elimination, thus resolves into the investigation of the coefficient:

$$b = [c^2 + p\,P_0 - h^2]/[8\,\pi\,NM]$$

while the frequency of surging, where such exists, is given by:

$$N_0\sqrt{\frac{(N\,e\,e_0\sin(a-\beta)}{4\,\pi\,z_0\,M_0} - \frac{(c^2 + p\,P_0 - h^2)^2}{64\,\pi^2\,M_0^2}}$$

Case (4), steady drifting out of step, has only rarely been observed.

The avoidance of surging thus requires:

(1) An elimination of the term h_2, or reduction as far as possible.

(2) A sufficiently large term c_2 or

(3) A sufficiently large term $p\,P_0$.

(1) refers to the design of the synchronous machine and the system on which it operates. (2) leads to the use of electro-magnetic anti-surging devices, as an induction motor winding in the field poles, short-circuits between the poles, or around the poles, and (3) leads to flexible connection to a load or a momentum, as flexible connection with a flywheel, or belt drive of the load.

The conditions of steadiness are:

$$\beta < a$$
$$c^2 + p\,P_0 - h^2 > 0$$

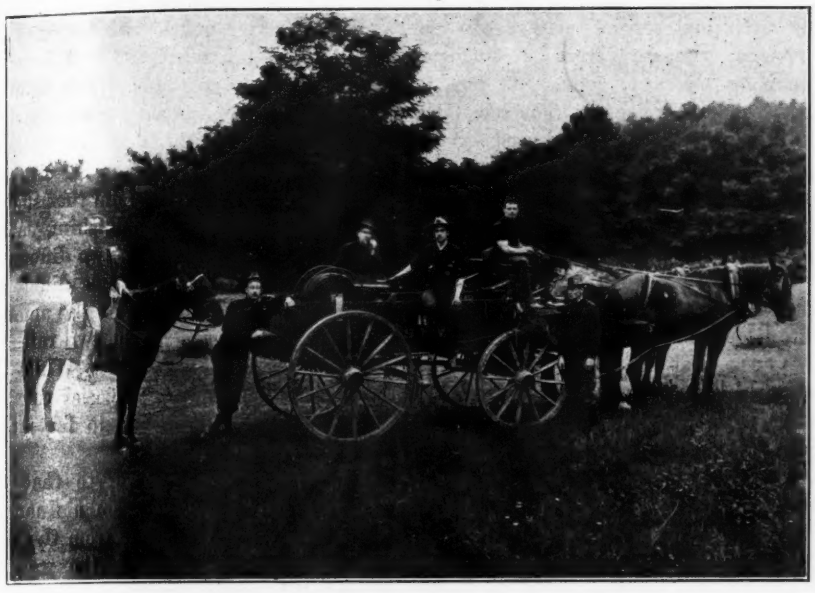
and if:

$$[c^2 + p\,P_0 - h^2)^2/(16\,\pi\,NM_0)] > [(e\,e_0 \sin(a-\beta)]/z$$

no oscillation at all occurs, otherwise an oscillation with decreasing amplitude.

Electrical Service in Military Operations.

During the recent visit of the Thirteenth Regiment, Heavy Artillery, N. G. S. N. Y., to Peekskill, N. Y., Company M gave a demonstration of improvised submarine torpedoing, the apparatus being put together with what could be picked up in camp. Out of black powder, axle grease and two empty kegs, the detail manufactured a water-tight mine which was sunk about 150 yards off the outpost, connected by rubber insulated wire with an incandescent light fuse, and successfully discharged. A second mine was put under the water-logged hull of a brick schooner that had been fast in the mud near a railroad trestle for the last thirteen years. This work was successfully accomplished late at night without lanterns, and although the charge used was not strong enough to destroy the derelict, it tore its hull apart, inflicting considerable damage.



THE FLYING TELEPHONE OUTFIT AT THE MILITARY MANŒUVRES, STATE CAMP, PEEKSKILL, N. Y., JUNE 25.

Probably one of the most interesting features of the week that this organization had at the instruction headquarters was the work done by the flying telephone line. This was manned by a detail from Company M, under the direction of Sergeant M. C. Sullivan. They practically performed the service of electrical scouts. The complete outfit consisted of a regulation army wagon upon which a reel had been built by the carpenters, and served by a detail of six men. Portable telephone instruments were used, strapped to carrying cases on the backs of the scouts. The three miles of insulated wire was laid with great rapidity and so placed that the scouts could bridge in and make connections at any point on the line. The work done consisted principally of notifying the gunners of the results of the firing, the scouts being located in a bomb-proof shelter in close proximity to the targets. The instruments were specially designed to operate over a line the insulation of which between conductor and earth could be very low, and in case it became broken from any cause would still be able to render service. The design was a departure from that generally used on commercial lines in that it required more battery power and a little louder speech to get good results. The line built was of the most temporary character, no effort being made in its construction for its preservation, except to avoid the obstruction of gateways going along the road. It was reeled from the wagon as though it were rope, and could have been built with the team going at a trot had occasion required it. The insulation of the line to earth was found to be very low, but its conductivity was very high, being composed of No. 14 B. & S. high-grade copper.

The camp end of the line was grounded to the waterworks. The target end was made by forming a pool and submerging a number of metal washbasins connected together. The accompanying illustrations show the service outfit, which of course is not the best that might be used. This is a regular four-wheeled wagon from the quartermaster's department. With a two-wheeled wagon the range of operation would be very much increased, and the speed with which the conductor could be laid down made more rapid. Another illustration shows the scouts at the furthest point of advance, the officer in charge giving directions to the operator who has his instrument strapped to his back, the receiver and transmitter being carried.

The men who formed the detail in carrying out the work are mostly students of technical institutions and are very enthusiastic over this opportunity to put into practice the work upon which they are studying, and the great satisfaction that has been given to the officers and battery commanders will no doubt greatly increase the use of the telephone in coming military manœuvres.

THE ELECTRICAL SCOUTS, MILITARY MANŒUVRES, STATE CAMP, PEEKSKILL, N. Y., JUNE 25.

NEEDED IMPROVEMENTS IN INDEPENDENT TELEPHONY.*

BY L. W. STANTON.

Our several subjects are of vital importance to the Independent telephone movement, and it is only through the proper realization of these problems that the Independent companies may hope to maintain the standing that this great independent movement has attained. Our competitor the American Bell has a well organized and disciplined force of employés, standardized apparatus of the highest type and years of practical experience.

The Independent telephone companies have popularized telephones and placed thousands of telephones in residences and places of business undreamed of before the advent of independent telephony. They have achieved wonders and astounded the telephone world with the progress they have made during the comparatively brief period of time they have been in the field. They have yet their crucial period to meet.

There are three giant problems, tariff, traffic and equipment, which are deserving of as much sound consideration as any problem in the industrial field to-day.

Public sentiment has been a very prominent factor in the independent field, but it is becoming more and more apparent that the company giving the best service and the most courteous treatment will secure the business.

The discriminating public have favored the home companies on account of their origin and the conditions under which they were brought into existence. This protection has extended over a number of years, but the time will arrive when the Independent companies, even though they be owned locally, must demonstrate their ability to furnish as good or better service than their competitor. The writer is acquainted with several Independent exchanges in which the service is inferior to that of the Bell company, yet the public tolerate it remembering the treatment they formerly received before the inauguration of the Independent companies. This will not always exist. The public is prone to forget.

The company furnishing the best service to the greatest number at an equitable rate will, unquestionably, do the greater business. For the Independent companies to bring about such conditions requires a far-reaching revision in their present tariff system, a change in their engineering and equipment, and attention to details in traffic, the like of which they have never known before.

In our larger cities there are thousands of families and hundreds of small tradesmen that can not afford to pay for flat rate individual service, neither can the telephone company from a financial standpoint afford to reduce its rate to meet these requirements. The inevitable result is party lines and measured service. I know a great many are opposed to this class of service; some for reasons which are valid and some for reasons which are thought to be valid but which are not. There has been a great deal of prejudice against the party line owing to poor apparatus and inferior traffic arrangements.

A great deal has been due to public sentiment, which is unjust to the telephone company and unjust to the subscriber who can not afford individual metallic service. By the use of the party line thousands of subscribers can be served that could not otherwise afford individual service. With a good system of four-party line selective, with the traffic details well worked out, this service for the small user is almost as good as individual service. You say that it works an injustice to the subscriber who has individual service. It is quite the reverse. It is optional with him whether he will use the party line or not, but in ninety-nine cases out of a hundred he is glad to have a chance to telephone to his party even though it be over a party line.

COMPARATIVE DATA—PARTY LINE SERVICE—6,000-LINE EXCHANGE.

No. of Telephones Per Line.	Average Cost Per Line.	Rental Per Line Per Year.	Cost to Operate Per Line.	Interest on Investment Per Line.	Depreciation Ten Per Cent Per Line.	Total Cost Operating Interest and Depreciation Per Line.	Net Earnings Per Line.	Net Earnings Per Telephone.	Net Per Cent Earned on Investments Per Line.
1	$100	$48	$15	$5	$10	$30	$18	$18	$18
2	125	$36–$72	22.50	6.25	12.50	41.25	30.75	15.62	24 3/5
4	175	$27–$108	37.50	8.75	17.50	63.75	44.25	11.06	25
		24– 96					32.25	8.03	18
8	275	$20–$160	67.50	13.75	27.50	108.75	51.25	6.41	18.6
		18– 144					35.25	4.40	13

A great deal has been due to public sentiment, which is unjust to the telephone company and unjust to the subscriber who can not afford individual metallic service. By the use of the party line thousands of subscribers can be served that could not otherwise afford individual service. With a good system of four-party line selective, with the traffic details well worked out, this service for the small user is almost as good as individual service. You say that it works an injustice to the subscriber who has individual service. It is quite the reverse. It is optional with him whether he will use the party line or not, but in ninety-nine cases out of a hundred he is glad to have a chance to telephone to his party even though it be over a party line.

From the foregoing we see that the party line is a success from a financial standpoint, and a necessity from the view that the company serving the greatest number of people renders a service the more valuable and will, therefore, secure the business, if the service is kept up to the standard.

We will now look at the party line from a traffic and tariff standpoint, which is an exceedingly complexed problem. There are three principal objections to the party line:

First, the annoyance from the bells ringing when some one else is wanted; second, the frequent report of "line busy;" third, service is not private.

The first objection can be almost entirely eliminated on party lines of four or less, providing the equipment is of proper design and the operating is good.

The second is a more difficult problem. If there are two or more parties on the line with unlimited service the line will frequently test "busy." To remedy this some form of measured service will be

Let us now look into the financial aspects of the party line. We will assume the exchange from which we draw our figures to be one of 4,000 lines, built at an average cost of $100 per line, and $25 extra for each additional party line telephone, including the telephone, interior wiring, line drops, etc. We will assume the rate for individual service to be $43 per year, $15 per year for operating individual service telephones, and $7.50 per year to operate each additional party line telephone. Figuring interest at five per cent and depreciation at ten per cent on the amount invested, we find by referring to the chart that upon doubling the number of telephones on the line and decreasing the rate one-quarter, we decrease the net revenue per telephone, and increase the net revenue per line. What is most noticeable is that the net per cent earned on investment per line is greater for both two and four-party line than for either a greater or less number; a point that should not be lost sight of in establishing party-line rates is that a dollar or two difference in the rate makes considerable difference in the net per cent earned on the amount invested, as is shown by the two rates on the four and eight-party lines. While the above table lays down no special rules to work by, it calls attention to facts that should not be lost sight of.

* Read before the Independent Telephone Association of the United States, at Philadelphia, June 25.

necessary. While it is admitted that measured service adds complications, it is undoubtedly the most equitable method of charging. While there are several forms of measured service, there is none that entirely fills the requirements. Automatic apparatus, either at the telephone or on the switchboard, is not satisfactory, for in the case the line called for should be busy there would be a call registered without the party securing the service. With either a meter or slot machine placed at the telephone it slows the service, for the operator must remain in on the line until the called for party is secured, and the calling party has registered or deposited the required coin. This also works a hardship on the party called for, as it is necessary to wait until the party calling deposits the coin or registers. The system of measured service, where a meter is used, is also more expensive, inasmuch as it requires a visit to each telephone to take the reading of the meter before a bill for service can be rendered.

The system in use in a number of the largest Bell exchanges and the one which gives the best general results is, where the operator marks down the number of the telephone of the party calling and in case the call is not completed she draws a line through that number. Each hour these sheets containing the record of the calls are collected and sent to the billing department.

Measured service handled in this way gives the subscriber very prompt and efficient service. This class of measured service used in connection with a four-party line will give excellent results. Suppose you allow each party line subscriber 600 or 1,000 outgoing calls per year on a four-party line or 1,200 to 1,800 on a two-party line, at a minimum charge with a fixed rate per message for all additional calls; all incoming calls free. Handled in this way the report "line busy" will be no more frequent than it is with individual unlimited service; in fact, the calls will probably average less per four-party line than with unlimited individual lines.

In a peg count which the writer examined where there were nearly 5,000 party line telephones, all of which were either measured meter or nickel service, the average call per day per telephone was 1.3.

In regard to secrecy or privacy of a properly designed party line telephone, it is almost as private as an individual telephone. With a lamp signal board and selective ringing, the different parties on the line have no means of knowing when a party is calling or being called, and if a line is in use they can readily hear another party come in on the line. With the three main objections just cited handled as above described, the party line gives a very desirable service and comes within the reach of a class of patrons or users that would otherwise be barred. From the foregoing it is plainly evident that the party line has a mission of importance to fulfill.

Up to the present time the call for the party line equipment has not been very great and the independent manufacturers who have done so well in furnishing equipment, have not given this subject the attention that it should receive in the future. One of the leading manufacturers is just placing on the market a four-party selective system which depends upon the number of frequencies to operate the bells. From the limited experiments the writer has had an opportunity to make, the system seems to possess valuable points over the pulsating bell type, which has been used by the Bell company.

Before party line service can become thoroughly commercial among the Inpendent companies the manufacturers will have to revise their design of equipment. The following diagram illustrates very plainly the line circuit of most of the manufacturers. From this we see that either one or both sides of the line are permanently tied to the central battery, which is grounded. This makes four-party selective signaling very difficult, if not impossible. While the Independent companies are beginning to realize the value of the party line, they need to equally realize the danger there is of very seriously impairing the efficiency of their present service. If inferior apparatus is used, or if the apparatus is not properly installed, or if the operating is not under proper discipline, the service will be such that the company will lose rather than gain by adopting party lines. One of the greatest needs of the Independent telephone interests is either for this association or a kindred association to take up, in a technical way, the practrical subjects of traffic engineering and equipment. There are thousands of dollars being wasted through ignorance, which could be avoided to a considerable extent by action on the part of such an association. If independent telephony is to be a real force in this country such an association must, sooner or later, be organized.

There is no progressive art in which the practical exponents do not get together and discuss the practical and technical problems which actually arise, and in such an industry as telephony it is particularly desirable, for in no other industry does the equipment and welfare of one company so intimately affect the other. Being linked together as they are, or soon will be, by one vast network of long-distance lines to the end that one huge national system of intercommunication is established. With the millions there are invested and the opportunities there are open, it is a crime to the Independent telephone interests that a little closer union and more uniform equipment is not adopted. The day for long-distance telephony is just in its infancy, and for the Independent companies to handle their share of the traffic and give the class of long-distance service that will be demanded, they will be compelled to adopt a more standard form of equipment.

The writer's experience on the United States Telephone Company's long-distance lines is that where twenty-volt and forty-volt common battery systems made by different manufacturers are connected the results are unsatisfactory. So much so in one case, where a forty-volt system was installed, the former toll business at that place was almost lost for a period, owing to the inefficiency of the system for long-distance work. Later a change was made that remedied the condition to some extent, but the system has never given the service it should. The trouble just cited was not due to the fact that it was a forty-volt system, which voltage is probably nearer correct, but due to the fact that the system was improperly designed for receiving incoming toll business.

The above well illustrates why telephone apparatus should be standard. From the output of the various independent manufacturers there could be selected a line of high-class apparatus that would be worthy of standardization.

Our competitor, the American Bell, has standardized apparatus, and the Independents, until they adopt standard equipment, will necessarily give an inferior class of service.

If a traffic and engineering association were formed there are many subjects pertaining to engineering and traffic on which articles should be written and thoroughly discussed, which would be of inestimable value to the Independent movement.

Any member attending such an organization for a so-called good time instead of a desire to contribute toward the material

welfare of the body and interests it represents should be dropped from the association.

The problem of giving long-distance service makes such an organization doubly necessary. If the Independents expect to handle long-distance business in an up-to-date manner, deriving the greatest amount of revenue from the capital invested, building their connections by ticket wire and leasing their wires to brokers and large corporations to use their telegraph, while the telephone company is using the same for telephone purposes, considerable forethought and sound engineering will be required.

If the long-distance trunk lines are to be built by different companies, they should consult each other, decide upon the class of construction and equipment, and more important yet, the location of their relay or switching stations. I mean locations along the trunk lines where testing for trouble is done, where operators are located for switching purposes, and where telegraph apparatus, such as relays, repeaters, Morse panels, batteries, etc., is located for handling leased wire work. The proper location of these switching stations is a very important matter. They should be located a certain distance apart to get the best results from the telegraph apparatus. They should be located at junction points on the east and west and north and south trunk lines. This location is very important from three points of view. It is very important from a view of economically and properly handling the Morse or telegraph. It is important from the fact that the operators should be able to switch their messages to any point of the compass; and third, it saves the expense of building and maintaining additions at switching stations. From the foregoing I am in hopes that the Independent companies will realize the absolute necessity of an association, to solve the problems that can not be solved by each company working independently.

The Manhattan Transit Company.

The valuable franchise rights and property owned in New York city by the General Carriage Company have been transferred to the Manhattan Transit Company, and the following named gentlemen have been elected directors: Lord Kintore, Lord Grey, Sir Charles Rivers Wilson and C. S. Drummond, of London; Harold Walker, W. G. A. Hemming, W. J. Arkell, W. K. Gillette, Walter H. Knight, James B. Brady and State Senator Patrick H. McCarren, of New York. Mr. Drummond was elected president of the corporation, and Mr. Arkell chairman of the board.

It is understood that Mr. W. J. Arkell will have active charge of the affairs of the company, and it is planned to enter the field of local haulage and heavy deliveries of all kinds, in addition to supplying a regular automobile service. The company utilizes three systems of propulsion, electricity, gasoline and steam.

PACIFIC COAST ELECTRICAL NEWS.

The Northern California Power Company, whose principal office is at San Francisco, has decided to build an additional electrical power plant on Cow Creek in Shasta County, about twenty miles from its present plant at Shingletown. Two 1,500-kilowatt generators will be installed in a stone power-house. These will be direct-connected with water-wheels operated under a head of 1,200 feet. The two plants will be connected by a pole line. The present capacity of the company's Shingletown plant is 4,000 horse-power. Additional generators, with a total capacity of 3,000 horse-power, have been ordered and will be installed there. The company owns plants at Redding and Red Bluff, besides having substations at Keswick and Iron Mountain. Electricity is now being transmitted to Tehama, Vining and Corning, and a pole line will soon be completed to Willows. The voltage on the lines is now 20,000 and will be increased to 34,000 as the system is extended. H. H. Noble, of San Francisco, is president of the company.

The new electric pumps for draining the Comstock mines in the Sierra Nevadas will be located in a large chamber in the 2,150-foot level of the C. & C. shaft. This is being cut out of the solid rock at a point thirty feet north of the shaft station.

The stockholders of the United Gas and Electric Company, San Francisco, at a recent meeting authorized an issue of bonds to the amount of $2,000,000. The money realized will be used for improvements and to take up existing indebtedness. The company recently absorbed the three companies supplying gas and electricity in San Jose, Cal. These were the Electric Improvement Company, the Consolidated Light and Power Company, and the San Jose Light and Power Company. The new company will consolidate the electric plants under one roof and will operate but one gas plant, which will be enlarged. The pipe line for gas will be laid to connect the plant with Redwood City and other points. The electric current from the transmission lines of the Standard Electric Company will be distributed by the United company in Santa Clara and San Mateo counties. The Pacific Power Company, with headquarters at 23 Stevenson street, San Francisco, has also been acquired by the United Gas and Electric Company. This company's underground system will be rebuilt and utilized for the distribution of the Standard Electric Company's power. The contract has been closed by this company to light the streets of San Jose, on an all-night schedule.

The Union Electric Light and Power Company, San Francisco, which is now working on its hydraulic system near the Big Oak Flat road, leading into the Yosemite Valley, will construct an electric power plant this year, from which power will be transmitted to the mines on the Mother Lode. Two dams will be required for the first of its three plants. The water developing the power can be used over several times, and it is estimated that 30,000 horse-power can be developed under heads varying from 600 to 1,750 feet.

The Standard Electric Company, San Francisco, recently sent a force of linemen fo Blue Lakes to begin work on the pole line which will connect the mines near Commanche with the company's electric transmission system. The extension of the lines to Lodi and vicinity is being considered. The Livermore Water and Power Company now obtains its electric power from the Standard Electric Company's transmission system.

The Independent Electric Light and Power Company has renewed its contract with the United Railroads of San Francisco for power for the operation of the San Francisco & San Mateo electric line. This road extends from San Francisco to Baden and is being extended to San Mateo.

Chief Engineer Finckle, of the California Power Company, Bakersfield, Cal., states that the United States Government has granted the company a right of way across the government forest reserve in Kern County.

The Riverside Power Company, Riverside, Cal., has just placed an order with the General Electric Company for two 250-kilowatt, three-phase generators for its water power electric plant.

San Francisco, June 27. A. P. B.

The American Electrotherapeutic Association.

The annual meeting of the American Electrotherapeutic Association will be held at the Hotel Kaaterskill, Catskill Mountains, N. Y., on September 2. 3 and 4, 1902. In addition to the scientific discussion there will be local excursions, concerts, a reception and banquet, and a special vaudeville performance. It is understood that the usual reduced rates, both for railroad and hotel service, will be made to members, their families and friends.

This association has held several successful meetings, and this one promises to be as well attended as any previous gathering.

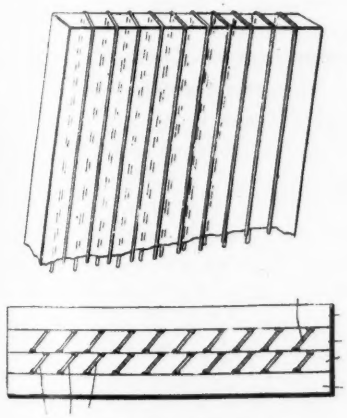
Electrical Patents

A rather novel scheme for insulating conducting wires has been patented by Messrs. Hermann and Ernest Hammesfahr, of New York city. Their idea is to incorporate in the insulation a covering layer formed of strands of filaments of spun glass braided upon it in exactly the same manner that textile covering is now

NOVEL IDEA FOR INSULATING CONDUCTING WIRES.

applied. One or more layers of this braided spun glass may be employed, and they may be separated by an intermediate layer of braided cotton threads. The exposed face is suitably varnished so as to protect the thin filaments.

A new process of making electric brushes has been patented by Mr. Robert D. Laughlin, of Ravenna, Ohio, which has been purchased by the National Carbon Company, of Cleveland, Ohio. The object of the invention is to cheaply produce an electric brush which is not liable to become warped or cramped during the manufacture thereof, especially during the baking process. It consists, broadly stated, of an electric brush composed of a mass of baked carbon in which are em-

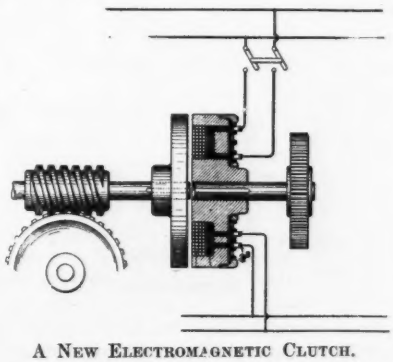


A NEW PROCESS FOR MAKING ELECTRICAL BRUSHES.

bedded a plurality of separate wires that run longitudinally only through the brush, and it also consists in the process of constructing the same. In carrying out this process, a plate of green carbon is formed by forcing plastic carbon through suitable dies, thereby forming ribbons of the required thickness and widths, which ribbons are cut to the proper length to form the plates. Certain of these plates are provided on their opposite side faces with longitudinally disposed grooves in which copper wire of the desired gauge is wound. The plates are then laid together, the outermost, however, being plain and not having wires. Suitable pressure is applied to these plates to unite them in a homogeneous mass of carbon in which the wires are embedded. This being accomplished, the brushes are then baked in the usual oven and completed. Before they are used, however, the ends are ground off, removing the wire loops which connect the respective longitudinal strands of the wires.

Mr. John A. Heany, of Philadelphia, Pa., has discovered a method of insulating metallic surfaces or wires with asbestos, and has obtained patents, not only on the method, but on the article. Heretofore the use of asbestos as an insulating material has been limited by reason of the fact that it could not be applied to the metal in a thin, pliable form, and yet be made water-proof, fireproof and adhesive under conditions of excessive heat applied through the metallic surface or extraneously applied to the asbestos covering. As is well known, asbestos is an absorbent of moisture and is not absolutely fireproof, because if exposed to a Bunsen flame the fibre of asbestos loses its flexibility and becomes exceedingly brittle by reason of the driving off of the water of crystallization. When so heated, a chemical change in the asbestos results in its deterioration as an insulating material, the asbestos being converted into oxide and the fibre made brittle. The principal object of this invention is to provide an insulation or covering for electric wires or metallic surface which shall be fireproof, water-proof and sufficiently thin, pliable and adhesive to permit the wire or surface to be bent into helices or coils without impairing the efficiency of the covering. In carrying out this idea the metallic wire or surface is first coated or covered with a paste or cement containing the following ingredients, to wit—first composition, fish glue or gelatinous or albuminous substances combined with lime, either wholly or partly slaked; second solution, sulphate of ammonia, boracic acid, sulphate of soda, chloride of ammonia, chloride of soda and water. After either the first composition or the second solution has been applied to the metallic wire or surface the asbestos is first treated with the second solution containing the chemical salts, as above set forth, and is then dried, picked into flaky and fibrous form, and then twisted under pressure upon the coated and sticky wire or metallic surface. The asbestos covering thus applied is then covered or coated with a paste or cement containing the first composition of lime with the albuminous or gelatinous material mixed with the solution of chemical salts, as above set forth, and, if desired, is again pressed down upon the wire or metallic surface. The coating or covering thus applied to the metallic wire or surface will be found to be a perfect insulation, water and fireproof, thin, pliable and flexible, and adhering to the wire or metal surface under extraordinary conditions of temperature. If desired, and in some instances this is preferable, the wire or metallic surface before it is covered with either the first composition or the second solution, as in the first instance, may be treated or immersed in a bath of zinc chloride, which chloride is allowed to dry upon the wire or surface before the first composition, containing lime and albuminous or gelatinous substances combined with the solution of chemical salts, is applied to the wire. The zinc chloride in this instance serves not only to clean the wire or metal surface, but when the wire or surface is subjected to extreme heat after the insulation has been applied the chlorine is driven off, and metallic zinc remaining will chemically combine with the metal surface and with certain of the ingredients of the paste or cement. The adhesion of the asbestos to the metal wire or surface is thus increased. These several patents have been assigned to the Teter-Heany Developing Company, of Philadelphia, Pa., and Charleston, W. Va.

In many applications involving the use of electromagnetic clutches, it is essential, for the proper operation, that the clutch shall release as soon as the controlling circuit is broken, but, as is well known,

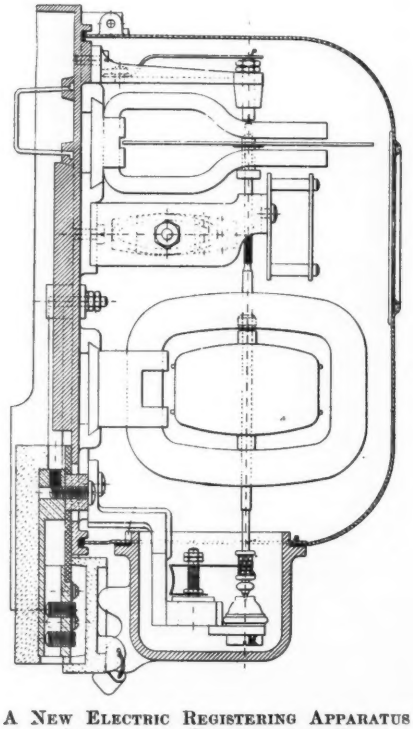


A NEW ELECTROMAGNETIC CLUTCH.

the members are apt to stick when the circuit is cut off, owing to the "coercive" force of the metal. Mr. Harold W. Buck, of Schenectady, N. Y., who has been working in this line of invention, has pro-

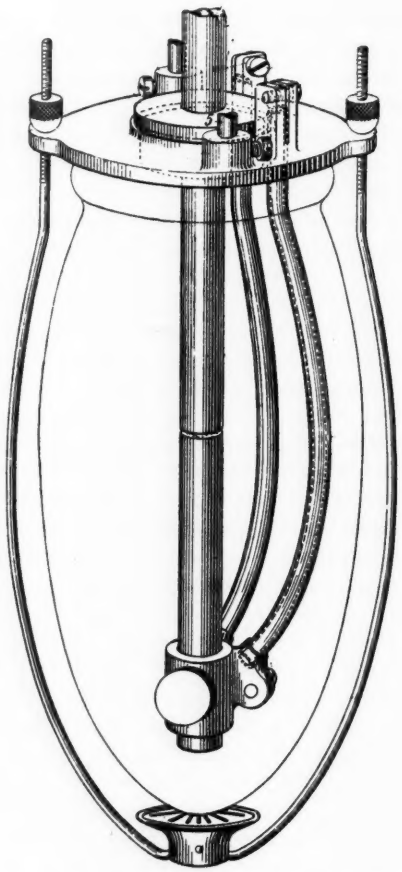
duced a clutch in which the above-noted objectionable feature is entirely obviated, and the General Electric Company has obtained control of the patent issued for the same. The clutch is made up of two members constructed in substantially the ordinary manner, one of the members having the usual energizing winding which may be of any desired type and is supplied with current from suitable means through brushes and their associated collecting rings that are mounted upon the member. In addition to this, however, Mr. Buck has devised an auxiliary demagnetizing winding arranged upon the member, and permanently connected in circuit with the same mains to which the energizing winding is attached. The auxiliary winding is so proportioned that it produces a constant magnetomotive force opposed to the magnetomotive force produced by the energizing winding, and sufficient to exactly counteract the coercive force of the metal when the energizing circuit is open, thereby reducing the magnetization to zero. As a result, there will be no sticking between the clutch elements when the energizing current is cut off.

Two French electrical engineers, Messrs.



A New Electric Registering Apparatus with Interlocked Supplemental Casing.

Francois A. Brocq and Arthur Blanchet, both residing in Paris, have patented in this country a new feature in electric meters, and this patent has been assigned to the Compagnie Pour La Fabrication Des Compteurs Et Materiel D'usines A Gaz, Societe Anonyme, of Paris, France. The idea of the inventors is applicable to any meter of the motor type, the object being to arrange the operative parts of the meter in such a way that the commutator and brushes, which require inspection and cleaning or renewal from time to time, may be accessible to an authorized person without rendering the other parts accessible, so that there will be no opportunity to tamper with the parts which indicate the meter reading. To this end, the usual main casing is employed, having an opening in its lower end normally closed by a supplemental casing that can be locked or sealed in place. The main elements of



A New Feature in Electric Arc Lamps of Increased Efficiency.

the meter mechanism, including the wheel train and register, are enclosed in the main casing. The lower bearing, however, projects into the supplemental casing, and the commutator and brushes are also arranged in this casing. When, therefore, these parts are to be examined or repaired, it is only necessary to remove the supplemental casing, thus exposing the parts which require attention without giving access to the registering mechanism.

The Westinghouse Electric and Manufacturing Company has obtained control of a patent recently issued to Messrs. Walter L. Cheney and George R. Davison, Newark, and E. W. Skinner, of Arlington, N. J., on an enclosed arc lamp. The object of this invention is to provide means of an exceedingly simple character which will increase the efficiency of the lamps. The invention consists in utilizing as the side rod or rods for supporting the lower carbon one or more hollow metallic rods, and providing an opening in the side of one or both of the rods near the point where the arc is established. As a result, a commingling of the gases of combustion with the outer air, or with the air in the upper part of the lamp, takes place through one or both of the side rods or a portion thereof. In experimenting, it has been found advantageous to provide such a side opening in only one of the rods, the other rod being tubular in form and open at the top and bottom. The rod may, however, be solid or closed at the top and bottom, and the lower end of the rod in which the side opening is made is also closed. It is claimed for this construction that the lamp burns with greater brilliancy than the ordinary enclosed arc lamp, while the arc is longer and the vitreous coating of the carbons at or near their adjacent ends is avoided.

Comparison of Costs of Steam and Electric Haulage for Mines.

With regard to the cost of haulage by electric locomotives, compared with animal haulage, it is difficult to arrive at exact figures. The author of an interesting paper under the above subject, taking the results of a few colliery plants, has been able to gather that on the average there is a saving in favor of locomotive haulage of some sixty per cent in cost per ton, even when making an adequate allowance for interest on capital and depreciation of plant. These figures are for coal haulage, but there is no reason to doubt that equally good comparative results can be obtained by electricity in all other classes of mining work, including the recovery of gold. Much stress is laid upon the importance of electric power in connection with Australian gold mining, as in addition to the economy in fuel and water there is the great flexibility and ease with which electric power plants can be removed and reconstructed if mines are found to be of poor value and have to be abandoned, as is frequently the case in that country.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Polarization Capacity of Palladium.

M. Wein has made some interesting experiments in testing Warburg's theory of liquid cells, with special reference to the part played by occlusion of gases. Besides a maximum value, the so-called initial value of electrolytic polarization is of interest, since the electro-motive force of polarization is proportional to the quantity of electricity passed through it, as long as that quantity is small; that is, the initial polarization takes place evidently as in a condenser. In carrying out the experiments, the author divides the liquid cells into three groups according to their polarization capacities. The first group is represented by platinum electrodes in dilute sulphuric acid. These have small polarization capacity and small phase difference, practically independent of the frequency of the current. The second group has the so-called unpolarizable electrodes with a large polarization capacity decreasing at higher frequencies. The third group consists of cells with platinized platinum electrodes, which show high phase differences and polarization capacities. The author used palladium electrodes on account of their great occlusion of hydrogen, but found that they behaved practically like platinum. Even when coated with palladium black they behaved only as if their surface had been somewhat increased.—*Annalen der Physik* (Berlin), June.

A New Method of Measuring Small Self-Inductions.

Mr. Mansbergh Varley has described a method for measuring self-inductions of similar small solenoids in the course of an investigation on the magnetization of iron in rapidly oscillating current fields. The principle of the method depends on the relation between the maximum current obtained when a condenser is discharged through a circuit containing small resistance, and a self-induction in circuit. The maximum current which flows when a condenser of certain capacity is discharged through a circuit of low resistance containing self-induction gives a certain mathematical quantity, being the amount of electricity stored up in the condenser before the discharge occurs. If the capacity is kept constant and the condenser charged to the same potential every time, then the maximum current is inversely proportionate to the square root of the self-induction in the discharge circuit, and provided there is suitable means of comparing the values of the current for the different self-inductions, these can be compared one with the other. The condenser is best charged from the secondary of an induction coil, through the primary of which alternating current of four or six amperes is passed, and it is allowed to discharge through a spark gap of one millimetre or two millimetres, which ensures the potential being very nearly the same for each discharge. The maximum current is measured by passing it through a solenoid which is used to deflect a beam of cathode rays in a Braun's tube. The arrangement of the apparatus is as follows: The tube is excited by a Wimhurst machine, which may be driven either by a water or electric motor. A deflecting solenoid is placed just beyond the second diaphragm of the Braun's tube, and is mounted on an insulating stand. The alternating current which is sent through the primary of an induction coil is conveniently regulated by passing it through a few lamps placed in parallel with one another. The secondary terminals of the induction coil are connected to the two coatings of a battery of Leyden jars, the two coatings also being connected through the deflecting coil, the spark gap, and either a self-induction or a certain standard of comparison. The deflections are obtained on closing the primary circuit by means of a key, and may be read directly in millimetres on the screen of the Braun's tube if this be graduated; otherwise, it is easy to project a scale, cut in tin-foil and well illumined, on the screen.—*The Electrician* (London), June 20.

Liquid Fuel for Steam Purposes.

Mr. J. S. S. Brame has made many interesting notes on the use of liquid fuel for steam purposes. The author states that the possibility of burning liquid fuel with great advantage in most circumstances as compared with the solid fuel has long been recognized, and that it is astonishing that the practice has not been more generally adopted. The choice of a fuel for steam raising is not altogether dependent upon the evaporative efficiency and other advantages which a particular one may possess, but will of course be duly influenced by relative market prices, and this no doubt has had considerable influence against the adoption of liquid fuel on a large scale in this country (England). The fuel natural to the locality will always have great advantages over an imported fuel, and England having such valuable coal supplies to hand, while on the other hand having no great natural sources of liquid fuel, gives preference to that material which renders it most independent of outside supplies. Although gas tar and oil gas refuse may be frequently employed in a very economical manner, yet there is little doubt that with a greatly extended use of liquid fuel the prices of suitable by-products would be so enhanced that imported liquid fuel would remain practically in possession of the field. Any liquid hydrocarbon of sufficiently high-flash point may be used as liquid fuel. The residues from any manufacturing process may be utilized in an economical manner. Astatki, the residuum from petroleum distillation, has been extensively used in Eastern Europe, but tar oils and oils from tar gas plants are frequently employed. These oils are especially suitable for locomotive work, since most large railways make oil gas in considerable quantities for lighting purposes, and, moreover, have exceptional facilities for transporting the gas tar from small towns on their lines, where it can be obtained at a reasonable cost. From the numerous estimates of the calorific value of different liquid fuels, it is approximated that in centigrade units it has a value of 10,500, while for good steam coal a value of 8,000 to 8,500 may be taken. It will thus be seen that the liquid fuel has a decided advantage. The usual calculations of the theoretical heating value of a fuel fail to take one important factor into consideration, namely, the physical condition of the fuel. Thus, the determined calorific value of carbon is always that of solid carbon, the value for hydrogen being obtained experimentally for hydrogen gas; but although in coal the carbon is in the solid form, it is certain that in liquid fuels it has undergone the first change in the passage from a solid to a gaseous condition, and consequently carbon in a liquid form will have a higher calorific value by just as much heat as would be required theoretically to raise solid carbon to a liquid condition. Aydon has estimated that this is equivalent to an expenditure of some 3,500 calories.—*Nature* (London), June 19.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electric Motor Vehicle Equipment.

The Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., as a result of five years' experience in supplying motors to the electric vehicle industry, is now placing upon the market a complete line of standard automobile equipments, embodying the latest improvements in this class of machinery.

Each equipment consists of one or two motors, according to the requirements of the vehicle, with a corresponding controller and cable tips complete; also cut-out switch, battery indicating instrument, charging receptacle, plug and cable, the battery tray contacts with cable terminals complete, and the wiring and wiring diagrams, making up a very complete furnishing of such an equipment, including everything of an electrical nature pertaining to the motive power of an electric vehicle except the storage batteries.

The general mechanical and electrical design of the motors embodies the best features of railway and self-propelled motor-vehicle practice. The frames of the motors are cylindrical in shape, and are especially adapted for universal methods of suspension and facility of removal, inspection or repair. A convenient method of centering an attachment is designed, and the bolt holes in the end poles are so placed that, however the motor may be suspended, the commutator door can be placed in any one of four quadrants of an entire rotation, the design being as nearly mechanically universal as possible. The bearings on all but one size have babbitt lined boxes of generous dimensions, with automatic babbitt oilers, and a special machine will be furnished with either ball or babbitt bearings. These bearings may be removed without disturbing any other part of the motor. The armature is built up on a sleeve, making it possible to remove the shaft—the part most liable to injury in service—without disturbing the armature iron or commutator. The armature is machine-coil wound, the coils being banded to prevent them flying out at high-armature speeds. The commutator and brushes are large, and improved holders make these easily removable.

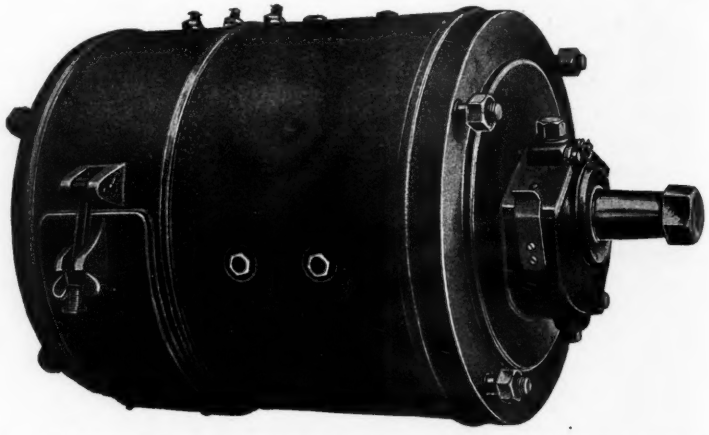


FIG. 1.—A REPRESENTATIVE MOTOR FOR AUTOMOBILE SERVICE, EQUIPPED WITH PLAIN BABBITT BEARINGS.

In constructing these motors, especial attention has been given to the requirements of road service, and the company claims that the ample capacity prescribed will sustain, without injury of any kind or permanent loss of efficiency, a load of 100 per cent above the normal rate for one hour, commutating perfectly up to at least 200 per cent overload. The efficiency is maximum at normal loads, and drops off only slightly at overloads, careful designing having been given these motors with a view of obtaining low-current consumption with a reasonable weight.

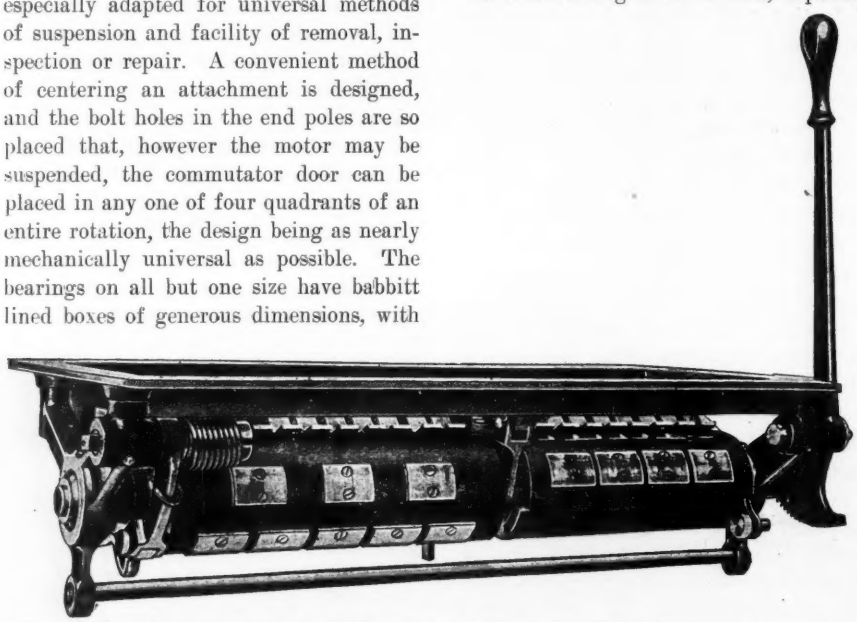


FIG. 2.—SIDE VIEW OF THE DOUBLE EQUIPMENT CONTROLLER FOR AUTOMOBILE SERVICE.

Special provision is made for the necessary torque for starting, hill-climbing or running through heavy mud without necessitating a heavy rush of current, which decreases the mileage possible in a given charge, to say nothing of having an injurious effect upon the batteries. In all motors, except two special equipments, the field-winding is arranged in two halves, allowing of a four-speed, series-parallel system of control, and reducing paralleling of the batteries to a minimum.

Fig. 1 shows the motor as equipped with the plain babbitt lined bearings. These motors are equipped to operate at weights ranging from 1,300 pounds to 11,000 pounds, according to the speed and the range of transport.

Fig. 2 gives a side view of a double equipment controller. These have either three or four speeds, both forward and backward, according to the type of the equipment. The reverse drum or switch is part of the controller, and an interlocking device is provided, acting between the main drum and the reverse drum, making it impossible to reverse the controller in any other than the off position, the main drum being locked in that position until the reverse drum is fully in the forward

position or in the reverse position. The controllers for single equipment have four notches given for uniform gradations of speed in either direction. When one of

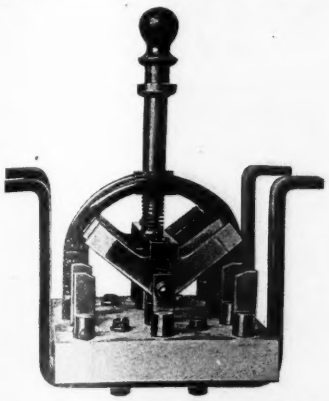


FIG. 4.—CUTOUT SWITCH FOR AUTOMOBILE SERVICE.

these controllers is used with a double-motor equipment, the connections are such that the batteries may always be in one group in series, and speed variation is accomplished entirely by series parallel arrangements of the motors and motor fields, which obviates the danger of unbalancing the batteries, rendering the wiring less complicated.

Fig. 3 shows the charging plug and receptacle. These are the same for all equipments, and have sufficient current-carrying capacity for the largest equipments furnished. They are of a concentric type, and the receptacles will fit the standard plugs usually found in charging stations.

Fig. 4 shows the cutout switch. At present these are made in two styles—a two-pole switch and a four-pole switch, the first to be used in equipments in which the cells of the battery are always in series, and the second where the battery is divided into two groups. There are three positions of the switch—the upper or running position; the lower or charging position, and a middle or off position, which corresponds to the hinging position of any switch on this type, and leaves all circuits open and every part of the apparatus accessible for easy repairing, without danger of short-circuiting. At the middle or off position the switch handle can be removed, which will prevent the use of the carriage by any one not having a similar handle. If mounted conveniently, it can be used as a safety or an emergency switch to open the motor and battery circuits at an instant's notice.

FIG. 3.—CHARGING PLUG AND RECEPTACLE FOR AUTOMOBILE SERVICE.

The New Liberty Light.

Alterations which have been in progress since early in April have been completed, and the torch of the Statue of Liberty, on Bedloe's Island, in New York harbor, is now brilliantly illuminated. Inside of the statue, instead of the oil lanterns previously used, there are now six enclosed arc lights, of 500 candle-power capacity each, with an additional thirteen incandescent lamps inside the foundation. The whole interior is now plainly visible. The care of the statue was transferred from the Lighthouse Board to the War Department on March 1, and the torch was without illumination for fifty-five nights.

Portable Measuring Instruments.

The Weston Electrical Instrument Company, Waverly Park, Newark, N. J., is the manufacturer of a fine line of electrical measuring instruments. This company has given every attention to the details of design and construction to bring its apparatus up to the severe requirements of the modern service. In Fig. 1 is shown the portable type E direct-current instrument. This is eight and one-half inches in width, eight and one-half inches long, and its height or depth is four and three-eighths inches.

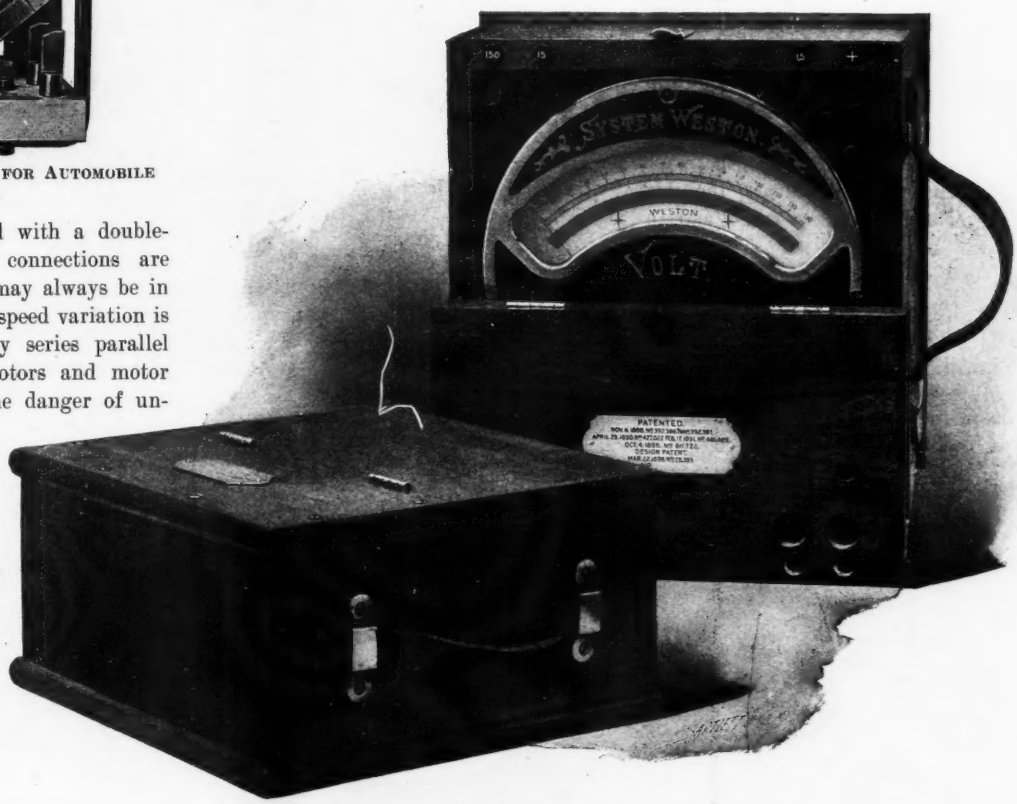


FIG. 1.—PORTABLE DIRECT-CURRENT MEASURING INSTRUMENT.

This type of instrument is adapted for use in many circumstances where tests are to be made, but where the extreme accuracy which obtains in the standard portable instruments is not necessary or desired. They are especially serviceable in central stations where stray magnetic fields exist, as the instrument proper is enclosed in an iron case which forms a shield against external magnetic influences, although care should be exercised not to subject the instrument to powerful magnetic fields which will permanently magnetize the iron case. The accuracy will be found sufficient, the company states, to enable employés of central stations to check up their switchboard instruments, and in general testing; and the effort has been made to make the cost such that it will be available to any one having

occasion to make electrical measurements. Fig. 2 shows a novel form of measuring instrument designed by this company, which has become very popular. This is a model duplex direct-current instrument. It is nine and one-half inches in length, seven inches wide, with a height or depth of two and one-quarter inches, and weighs about eight pounds. This type of instrument is also made in a slightly larger size, weighing about seventeen pounds. The name "duplex" is given to these instruments because they contain a voltmeter and ammeter in one case. For some purposes this combination will be found much more useful than two instruments in separate cases, as, for example, where practically simultaneous readings of current and potential differences are to be made. In an instance of this nature, the close proximity of the reading scales and indexes will be found to supply the really good feature of a quick and positive reading. In the model illustrated in Fig. 2 the two instruments are enclosed in a neatly designed and finished water-proof aluminum case, which closely surrounds the operative parts of the instrument. The use of aluminum for the case secures the minimum weight, and as the same material affords an excellent protection against the elements, the device is adaptable for outside work, where the instrument is exposed to the weather, or in cases where water or dampness would be likely to affect its work. A very large number of these instruments are in daily use throughout the country, and they are also very popular in foreign installations. Owing to the lightness and compact design, the company has been very successful in applying them to automobile service. In fact, extreme care has been taken in designing and constructing them to meet the severe demands imposed by continuous rough service on the road. The moving parts are so designed and constructed as to be able to bear without injury the constant vibration which such service involves.

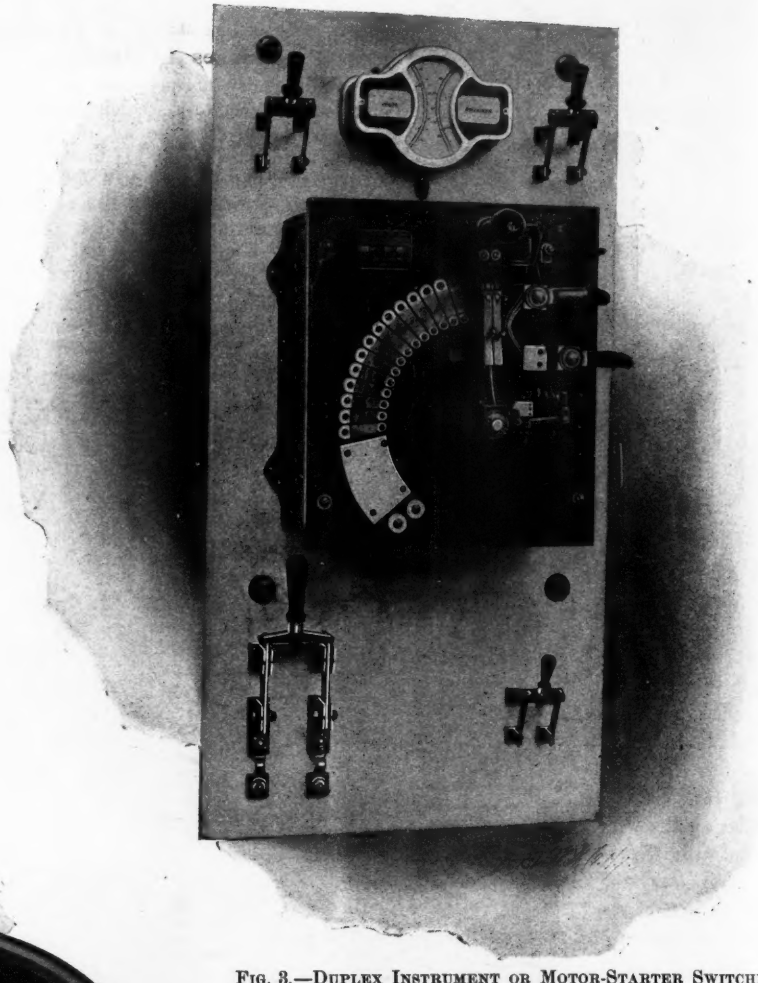


Fig. 3.—Duplex Instrument or Motor-Starter Switchboard.

Fig. 2.—Model Duplex Instrument, Combining Voltmeter and Ammeter.

Aside from their adaptability to use on vehicles, these instruments are also well adapted for use in other cases where extreme vibration is met with, or where space is limited and lightness is a desirable or necessary feature. For use on small switchboards, especially on motor-starter switchboards, they are found to render very valuable service in indicating the power used in driving a single machine or groups of machines. Figs. 3 and 4 show the application of these instruments for this purpose in the works

of the company manufacturing them. By their use in this manner it is easy to ascertain the power used to drive machines, and thus to charge the proper proportion of power to each department, or even to one machine. They also serve, when so used, to indicate abnormal conditions arising from friction or other causes, and in this manner it has been found that they

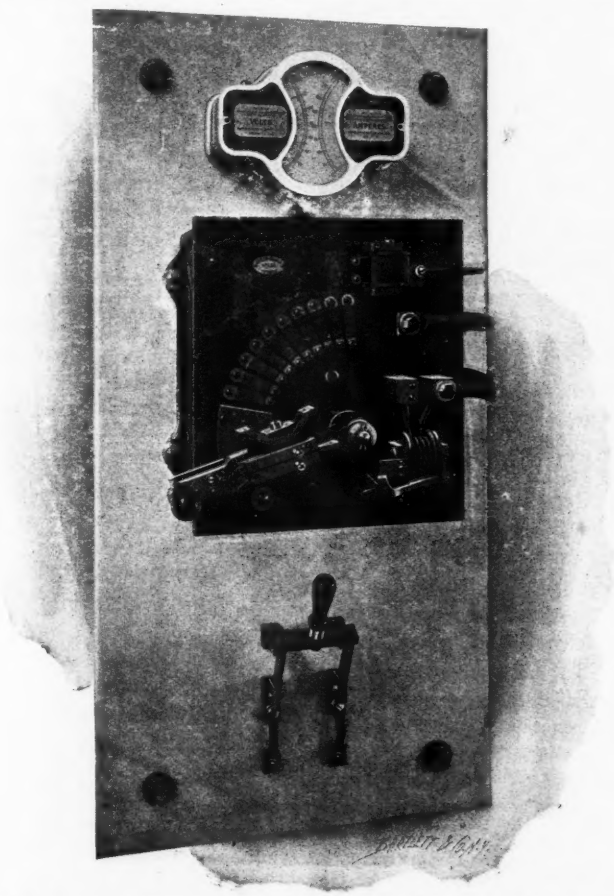


FIG. 4.—DUPLEX INSTRUMENT ON MOTOR-STARTER SWITCHBOARD.

are a material aid in securing economy of operation of machinery in general.

The company makes another model of this apparatus, the working parts of which are precisely the same as are used in the model described, with the exception that the scale is larger, and consequently the divisions more open for the same range. The case in this model is made of cast iron, and consequently is not water-proof. This model is well adapted for use in small isolated plants, and for all occasions where the existence of powerful external fields would render it impossible to use the other model. The function of the cast-iron case is to shield the instruments from external fields, and this it is claimed to do in a most effectual manner. In both forms of instrument the workmanship is of the highest order, and is under the direct supervision of Professor Edward Weston, the designer and manufacturer.

Some Unique Features of the Keystone Exchanges in Philadelphia.

The Keystone Telephone Company, having been in operation since the first of January, 1902, has now in operation approximately 4,000 telephones. These telephones are connected to the two exchanges known as the Main Exchange, located at Second and Sansom streets, and the Race Exchange, at Sixteenth and Summer streets. These two exchanges are connected together by trunk lines and are also connected with exchanges of the Eastern Telephone and Telegraph Company, at Camden, N. J., and Gloucester City, N. J. A third exchange, to be located on the corner of Preston and Filbert streets, is now in the process of construction, and it is anticipated that the exchange will be serving Philadelphia subscribers some time in July.

All three of the above exchanges are equipped with complete exchange apparatus furnished by the Kellogg Switchboard and Supply Company, of Chicago, Ill., and represent the latest engineering practice in that particular line.

A peculiarity of the system, which will commend itself as being a feature of great advantage, is that all the jacks in the switchboard are disconnected from the lines with which they are associated at all times excepting when they are actually in use for conversation. This is managed by the cutoff relay in the line circuit, which, at the same time that the lamp signal circuit is disconnected, connects the jacks to the line. This feature is of vital importance when it is considered that in a large exchange a very small stray foreign current may be the cause of a very large and destructive fire involving the loss of many thousands of dollars in actual cost of apparatus destroyed, besides the loss occasioned by the interruption to the service, which, in the case of a large exchange, is oftentimes of many months' duration. In the Kellogg system the worst that can happen under these circumstances is the destruction of the relay upon the particular line which has come in contact with the wire carrying the foreign current. The relays being individually mounted on the mounting strip, and individually encased in a drawn metallic shell, the damage is confined to the relays immediately concerned.

Another point in connection with these exchanges is that the jacks on the line have but one spring, and but two metallic connections. The tip of the plug connects with the spring of the jack, and the sleeve of the plug connects with the sleeve of the jack. The sleeve of the jack is also used to furnish the click in the operator's ear which acts as a busy test. For many years it was attempted by the engineers of both the Bell and independent companies to design a multiple common battery system which would have but two wires in the multiple. The two-wire multiple was first shown at the Pan-American Exposition, and since that time its utility has been demonstrated in the many large switchboards that have been installed all over the country, but most notably in Philadelphia. The extreme simplicity of the circuits connected with this system renders its liability to trouble very small. Paired cable can be used in the multiple, which renders the laying up of the multiple very neat and compact, at the same time the jacks, having but two soldered connections, are not subject to the ordinary troubles which have heretofore been common in the multiples containing three, four or five wires. On account of this feature several new exchanges now being built by this company will be equipped with jacks which are mounted in strips on three-tenths-inch centres, notably the exchanges for Buffalo and Los Angeles, Cal. By this means it will be possible to place a very much larger number of multiple jacks within the reach

of a single operator than has heretofore been possible.

Another feature of the equipment in use in Philadelphia is the mechanical construction of all the relays which are used on the system. The armatures of the relays are bent around the end of the core at an angle which is slightly greater than ninety degrees; the end of the armature which is next to the end of the core is drawn toward the magnet by the action of the current, and by so doing the opposite end of the armature, which engages the springs, is raised, thereby making or breaking the spring contacts, as desired. This armature, instead of being mounted in trunnions or bearings, is mounted upon a knife edge, by this means eliminating any possibility of sticking.

In general, the system used by the Keystone company may be described as a complete central energy multiple system, having a two-wire multiple, a line and cutoff relay on each line, with lamp signals, the relays being mounted on a rack in a separate room, adjacent to the exchange. Supervisory lamps are connected with each cord, the relays controlling the lamps being mounted in the rear of the section. A main distributing frame and intermediate distributing frame are used, incoming and outgoing trunks having lamp supervision and operated in connection with order wires are included in the equipment. All current necessary for the operation of the exchange is furnished from a central battery consisting of two sets of two cells each of chloride accumulator battery, which is charged by a special telephone-wound charging set, which is installed in duplicate. These charging sets are manufactured by the Holtzer-Cabot Company, Brookline, Mass., and are made according to specifications of the engineering department of the Kellogg Switchboard and Supply Company. On the trunk lines "busy back and don't answer" signals are given by means of two different kinds of noise, which is introduced on the line from an interrupter and transformer operating in connection with the ringing generators.

The Electrical Contractors' Association.

A New Jersey Central special train from New York to Philadelphia, for the annual convention of the National Electrical Contractors' Association at Philadelphia, July 16 and 17, will leave New York at the Liberty street station on Wednesday morning, July 16, at 9.30 o'clock. Accommodations on this train can not be secured after twelve o'clock noon, Tuesday, July 15. Members and their friends who expect to attend the convention are reminded that this splendid train, composed exclusively of Pullman parlor cars, has been arranged especially for their accommodation. A rate of a fare and one-third, on the certificate plan, has been granted by the Trunk Line Passenger Association. Fare from New York to Philadelphia, including parlor car seat on this train, will be $3, and the return railroad fare, when the certificate is properly endorsed, will be $0.84. Alexander Henderson is the master of transportation.

Book Reviews.

"Pocket Edition of Diagrams and Complete Information for Telegraph Engineers and Students." Willis H. Jones. New York. *Telegraph Age.* Leather. 260 pages. 4½ by 6¾ inches. 100 diagrams and illustrations. Supplied by the ELECTRICAL REVIEW.

This book is aimed to carefully and comprehensively take the student through the different phases of telegraph construction and operation, and the engineering phenomena of this subject. Considerable space is also given to the explanation of the telephone and the simultaneous operation of telegraphy and telephony. The "phonoplex" is also described, and a chapter is given to the subject of wireless telegraphy. The diagrams are carefully drawn, and the volume is so indexed that it may be an immediate help to the engineer should a special problem arise.

"Alternating-Current Machines." Samuel Sheldon and Hobart Mason. New York. D. Van Nostrand Company. Cloth. 260 pages. 5½ by 8 inches. Numerous diagrams and illustrations. Supplied by the ELECTRICAL REVIEW at $2.50.

This volume is the second on dynamo electric machinery, its construction, design and operation, by these authors. It is primarily intended as a text-book for use in technical educational institutions. There is no doubt but that it will admirably fill this function, as the authors are eminent in their line and have had much successful experience in developing the theory of the subject and in instruction of electrical engineering students. The book will also be read with great interest and profit by those electrical, civil, mechanical and hydraulic engineers who are not perfectly familiar with the subject of alternating currents, but whose work leads them into this field. There are several methods of treatment of alternating-current problems. Any point is susceptible of demonstration by each of the methods. The use of all methods in connection with every point leads to complexity, and is undesirable in a book of this character. In each case that method has been chosen by the author which was deemed clearest and most concise, and no use has been made of the method of complex imaginary numbers. The first four chapters of the book concern the relations which exist between power, electro-motive forces, currents and their phases in series or multiple alternating-current circuits, containing resistance, capacity and inductance. The next four chapters are devoted to the construction, principle of operation and behavior of the various types of alternating-current machines. Only American machines have been considered. The subject of alternating-current apparatus in connection with plants for the long-distance transmission of power is treated, and a chapter is given to the subject of tests on alternating-current circuits and apparatus.

"Electrical and Magnetic Calculations." A. A. Atkinson. New York. D. Van Nostrand Company. Cloth. 310 pages. 5¼ by 7½ inches. Fully illustrated. Supplied by the ELECTRICAL REVIEW at $1.50.

This is a book which the average student and ordinary reader will find of great practical value. Wherever it has been possible, the author explains in the simplest words the value and relations of the engineering features of these subjects. A great many examples are given in explanation of each step in the process of instruction, and the graphic illustrations and formulæ are made to be easily understood and avoiding complicated mathematics as much as possible.

Telephonic Communication between Great Britain and France.

A convention drawn up by the British Post Office has recently been signed by the French Minister of Commerce providing for telephonic communication between London and some 300 of the larger industrial cities in France. Hitherto the telephone line to Paris has been almost exclusively used for stock exchange and press messages, but with the new arrangement there is likely to be a large increase in the number of calls. A uniform charge of 8s. for a three minutes' conversation, which is the present Paris rate, will be made, and the use of the system will be restricted to subscribers to the state telephones of both countries.

The great pendulum, weighing twenty-seven kilogrammes, installed by Léon Foucalt in the Pantheon to afford a proof of the rotation of the earth, will soon be in an experimental state after having been laid aside since May 3, 1832, under decree of Louis Bonaparte.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

ANOTHER TELEPHONE ORGANIZATION — It has been announced that a new telephone organization, with a capital of $10,000,000, has been organized and will make its headquarters in Buffalo. This is the Consolidated Telephone Company, which has for its purpose the acquirement and control of telephone exchanges in New York and adjoining states. It operates as a holding and controlling company for the telephone exchanges and long-distance lines that it promotes, the plan being to organize individual companies in various towns, and then control their securities. The officers of the new company are: B. G. Hubbel, president; Charles E. Austin, first vice-president and treasurer; R. M. Parmely, second vice-president; J. H. Fuller, secretary.

A FIFTEEN MILLION DOLLAR MORTGAGE—The Virginia Passenger and Power Company, of Petersburg, Va., has filed a first consolidated mortgage on all its property held and to be held, to secure the issue of $15,000,000 five per cent gold bonds. The purpose of the issue is to provide for the equipment and betterment of the present lines, and for the acquisition of several other lines of railroad and electric light and power plants. In the deed there are conveyed nine and one-half miles of railroad track in Petersburg, several lines in Manchester and Henrico County, outside of Richmond; all the property of the Virginia Passenger and Power Company; the capital stock of the Home Electric Company; the Seven Pines Park and Land Company; the Brooke Turnpike Company; various tracts of land in Henrico, Chesterfield and Dinwiddie counties, and a ninety-nine-year lease of the property, rights and franchise of the Upper Appomattox Company.

MILWAUKEE PREPARES FOR LARGE POWER PLANT—The Milwaukee Electric Railway and Light Company has let a contract for probably the largest storage battery which has ever been ordered in this country. It is expected that it will cost some $250,000. This is only part of the improvements which the company intends to make upon its power plant, as it has plans drawn for the building of an entirely new plant which will cost $4,000,000. The company is putting 1,000,000 feet of conduit under the streets of Milwaukee this year, and this, together with the cables which will be put in them, will cost about $5,000,000. It has been stated that although the company at present has no use for more than one-tenth of the conduits being put in place, they are not to be used for a telephone system at any time. It has not been decided as yet whether steam engines will be used for power, or whether the plant will be equipped with new steam turbines. The storage battery, it is stated, will not only act as an equalizer, but will be used to run the railway and light currents at the same time should such a thing be necessary, as it is expected that the entire system can be run from this battery for an hour should any break occur.

ELECTRIC RAILWAYS

BAKER CITY, ORE.—The city council recently decided to grant a street railway franchise to C. L. Palmer.

EVANSVILLE, IND.—A right-of way has been granted for a traction line from this city to Henderson, Ky. The road will cost $200,000, and will be completed by November 1 of this year.

TORONTO, CANADA—Commercial Agent J. E. Hamilton writes from Cornwall, June 14, 1902: "The project of an electric line from Cornwall to Toronto is being rapidly pushed by American and Canadian promoters, who have a capital of $8,000,000."

TOLEDO, OHIO—An electric franchise will be asked of the city council in the near future by the company which is to build an electric road from Watonga, through Kingfisher to Guthrie and Oklahoma City. The parties back of the enterprise are the Gus F. Smith & Company, of this city. Work will soon be commenced.

COLUMBUS, OHIO—The Secretary of State has authorized the incorporation of the People's Rapid Transit Electric Company, of Toledo, with a capital of $100,000, to build and operate an electric railway from Greenville to Toledo, through the counties of Darke, Mercer, Van Wert, Paulding, Defiance, Henry, Fulton and Lucas.

BIRMINGHAM, ALA. — The Birmingham Railway, Light and Power Company has put new cars in operation on the new Wylam line. The new line to Ensley will be completed by August 1 and cars will be operated immediately thereafter. This line runs by way of the old fair grounds and Tuxedo Park, crossing the tracks of the old system in Ensley.

OAKLAND, CAL.—The Oakland Transit Consolidated Company has authorized an issue of bonds to the amount of $6,500,000. The sum of $3,000,000 will be spent in extending and improving the company's street railway lines, and the remaining $3,500,000 will be used to take up the existing indebtedness. The San Pablo avenue line will be extended to Point Richmond.

PORTLAND, ORE.—It is understood that the Gresham Electric Line will build an electric road from Portland to the proposed power plant on the Clackmas, thirty-one miles distant, and another branch through Powell Valley, the idea being to ultimately construct a line to Mount Hood. The proposed line will be built as soon as the right of way can be secured and preparations made. It is said the company will do a big business in the freight line.

LE ROY, N. Y.—The survey for the electric road to be put through this section by the Buffalo & Depew Company, which is to extend its line to Rochester, has been completed from Depew to some distance east of this village. The old Nunda & Rochester road was projected some twenty-five years ago, the right of way purchased, and about twelve miles of grading done, but for some reason was never finished. The grading remains practically as completed with a few exceptions, and is nearly ready for the ties and rails. This will greatly facilitate the building of the road.

MIDDLETOWN, IND.—It is understood that an agreement has been entered into by which the Richmond & Northwestern Company comes into the possession of all the rights and privileges of the Merchants' Traction Company, and will build an electric road from Richmond through Newcastle to Anderson. At the Richmond end of the line the road will connect with one extending through Hamilton, Ohio, and to Cincinnati. The Merchants' Traction Company at present has a franchise of Anderson streets and also has a franchise at Middletown for the main street. Considerable right of way has been secured between Anderson and Middletown, and a survey of the road has been made.

NORTH YAKIMA, WASH.—The company which has in hand the building of the electric railroad from this city to Sunnyside, now propose to construct an electric railroad from North Yakima to the Natches River. This road will be about twenty miles long and will be one of the most expensive pieces of road the company will construct in this country. The company has filed a water appropriation calling for 1,000 feet per second to be taken from the left bank of the Natches River, about forty miles west of this city. It is understood that the water is to be used in the generation of power. Work will be commenced soon on both lines. The survey for the Sunnyside line is now complete to a point about two miles from the town of Sunnyside.

NORFOLK, VA.—The consolidation of the Norfolk, Portsmouth, Old Point & Newport News electric railway and power companies —about fourteen in all—is now in effect, and general manager E. C. Hathaway is now in complete charge of the properties. At the regular meeting held recently in Portsmouth, R. Lancaster Williams was elected president of the new company, and William J. Payne first vice-president. They both belong to Richmond. It is not the purpose of the new company to make any change in the properties of the Newport News & Old Point Company on the Newport News, Hampton and Old Point side of the river. Caldwell Hardy, president of the Norfolk National Bank, will be elected second vice-president of the company at the next meeting, when the secretary and treasurer will also be elected. The following gentlemen are added to the board of directors: W. A. Post, general superintendent of the Newport News Ship Building and Dry Dock Company; Caldwell Hardy, Austin Lanahan, of Alexander Brown & Sons, bankers, of Baltimore. The vice-president states that there will be no reduction in the number of cars operated, and that the public will get improved service.

ELECTRIC LIGHTING

WALTHAM, MASS.—At a recent special meeting of the aldermen, a resolution favoring all-night lighting was adopted.

ALPENA, MICH.—The common council has entered into a contract with the electric light company for the lighting of the city.

MILWAUKEE, WIS.—An amendment to the articles of incorporation of the Milwaukee Light, Heat and Traction Company has been filed, which provides for the company supplying gas and water to its customers.

SAN JOSE, CAL.—The city council has closed a contract with the United Gas and Electric Company for the lighting of the streets for the next fiscal year. The contract begins January 1 and will continue for a year.

SAN LEANDRO, CAL.—The work of putting in the new arc lights has been started, and within a short time San Leandro's principal thoroughfare will be lighted. The new lighting system will be a great improvement over the old one.

SACRAMENTO, CAL.—The Sacramento Electric, Gas and Railway Company has a force of men engaged in hydraulic work preparatory to the building of an additional electric power plant, twenty-five miles north of Placerville. The distance of transmission to Sacramento will be sixty miles.

MUNCIE, IND.—The Muncie Electric Light Plant has closed a contract with the American District Steam Company, of Lockport, N. Y., for the construction work necessary for the new steam heating service to be installed there. The mains will be laid through the alleys in the business districts, and the work must be finished by September 1.

CORONA, CAL.—A petition has been circulated among the citizens of this place, asking that the city board of trustees call a special election for the purpose of submitting to the voters the question of bonding the city for $20,000 for the purpose of building a municipal electric light plant. The petition has met with no opposition, and has been liberally signed.

KENNEBUNK, ME.—At a special town meeting held recently it was voted that the sum of $4,000 be raised for the purpose of extending the electric lighting system to West Kennebunk, Kennebunk Landing, Kennebunk Harbor and Kennebunk Beach, and the treasurer was authorized to issue twenty-year coupon bonds to bear interest at a rate not to exceed three and one-half per cent.

SALT LAKE CITY, UTAH—The Big Springs Electric Light Company has been granted a franchise to erect electric light poles between the towns of Fountain Green and Moroni. This company, which is composed of citizens of the towns named above, has been incorporated for $20,000, and both towns are to be benefited by the electric lights it is intended to have in full operation in about three months.

NORRISTOWN, PA.—Work has actively been started on the new plant of the Norristown Light and Power Company. The buildings will be of fireproof construction and will be built to make extensions with great facility. The contracts have all been made for the engines and electrical apparatus and also the boilers. The general system will be duplicated and it is expected that the new plant will be in operation in the early fall.

MYERSTOWN, PA.—A meeting of citizens of Myerstown, Ruchland, Stouchburg, Sheridan, Newmanstown, and Womelsdorf held a meeting recently at Myerstown for the purpose of organizing a stock company to furnish electric light for these towns. Isaac Kegerries was appointed chairman, and L. H. Hostetter, secretary. The chairman will appoint a committee of two in each town to solicit subscriptions for stock at $10 per share. The outlook is promising.

SAN FRANCISCO, CAL.—The United Electric Gas and Power Company has purchased the Pacific Power Company's 1,000-horse-power generating station and underground distributing system. This will give the new company a nucleus for a distributing system for the electric current from the Standard Electric Company's transmission system. The Standard company will soon be transmitting power through San Francisco, where its allied company will attend to the distribution. The system is already in successful operation, supplying intermediate points.

COLUMBUS, OHIO—William A. Gill has been granted a franchise to use the streets, avenues, alleys, public grounds, etc., of this city for the construction and maintenance of a heating, lighting and power supply plant within the city limits. A resolution was adopted approving the plans of the Urbanna, Mechanicsburg & Columbus Railway Company for the construction of its tracks on Dublin avenue, Spring and Water streets, subject to the necessary modifications relative to curves and grading. The board also recommended the passage by council of an ordinance extending the completion of the road within the city limits from July 1 to October 1.

BINGHAMTON, N. Y.—At two meetings of the stockholders and directors of the Binghamton Light, Heat and Power Company, it was decided to increase the capital stock from $500,000 to $650,000; to issue mortgage bonds for $500,000, and to make improvements on the present plant to the extent of $250,000. In making the increase of the capital stock, the company will issue $150,000 of six per cent preferred stock. That amount will be sold at once, the old stockholders being given the preference. In issuing the mortgage bonds, it is expected to pay the bonds of the Binghamton General Electric Company with $400,000 of that amount, and have remaining from that $400,000 enough to make extensive improvements on the present plant. The remaining $100,000 will be held in reserve. The present office of the company will be removed from 79 State street to 172 Washington street.

TELEPHONE AND TELEGRAPH

ATLANTA, GA.—The city fire alarm and police wires will soon be underground in the conduits that have been provided for them, and many of the poles now in the streets will be removed.

WELLSVILLE, OHIO—The Steubenville Traction and Light Company has installed a private telephone system on the system of the Toronto-Steubenville Interurban Railway, each of the cars being equipped with a portable telephone.

LOS ANGELES, CAL.—Telephone service is being installed in the Arcade Station, Los Angeles, for the use of passengers. All Southern Pacific trains will be provided with telephone facilities by the Pacific States Telephone Company.

ALBANY, N. Y.—The Hudson River Telephone Company will build a new branch office in the West End. The new building will be located at the northwest corner of Quail street and Hudson avenue, and will be one story and a half in height. Work will be commenced at once.

BUFFALO, N. Y.—Burt G. Hubbell, general manager of the Consolidated Telephone Company, Buffalo, is building a long-distance telephone line to connect Buffalo with Rochester, Syracuse, Ithaca, Corning, Salamanca (N. Y.), and Meadville (Pa.). The line will be completed within a few weeks.

CLEVELAND, OHIO—The Willoughby Telephone Company, owned by the Everett-Moore Syndicate, has changed hands. The consideration was in the neighborhood of $10,000. The company has 150 telephones in operation. The purchasers are a company of Willoughby merchants, headed by Fred Storm.

BROOKLYN, N. Y.—The New York & New Jersey Telephone Company will build another building, nearly, if not equally, as large as its present one in Willoughby and Lawrence streets. It will be 100 by 110 feet in size, and located on the east side of Clinton avenue. The building will be ready for occupancy next April.

WILMINGTON, DEL.—The Delaware & Atlantic Telegraph and Telephone Company has begun work on its conduit extensions. The new ducts put down will run through about ninety squares, a distance of over six miles, and when the work is finished the underground system will extend to all the important bridges except Washington Bridge.

GREENVILLE, S. C.—The Citizens' Telephone Company, of Spartanburg, S. C., and the Home Telephone Company, of Greenville, S. C., have been sold at auction to satisfy a mortgage of $30,000, given on both plants by L. W. Floyd, of Newberry, S. C., and G. A. Browning, of Greenville, S. C. Both of these plants were purchased by Mr. Floyd. Mr. Floyd will probably continue to operate the plants.

ROME, N. Y.—It is understood that an extension of the Rome Home telephone line will be made from Vernon to Vernon Centre, Knoxboro and Augusta Centre. It is ex-

pected that work will be rapidly pushed as soon as the franchises are secured from the different town boards. A request has been received from Oriskany Falls for the company to bring the line into that village, making a total distance of twelve miles to build. Toll stations will be instituted at the villages, while the subscribers will be given a flat-rate service.

PITTSTON, PA.—Ex-County Controller Joseph D. Lloyd is at the head of a new company composed principally of Wyoming Valley capitalists, which is about to establish and operate a telephone system at Jackson, Tenn. Among those interested in the enterprise are Robert T. Pettebone, Dr. F. C. Johnson, A. D. Hay, C. Frank Brobst, Dr. A. C. Shoemaker, Frank P. Hopper, J. E. Nugent, Joseph L. Dunn, William Drury and E. R. Pettebone. The contract for the construction has been awarded to a Chicago firm and work has begun.

ONEONTA, N. Y.—Oneonta will soon be given direct communication with Albany and Binghamton, the Central New York company having recently decided to put in a copper metallic circuit between these places. The work now under way for this company also includes rebuilding all the old toll lines that have become weak or impaired, and they will be put in the best possible condition. In all about 1,200 miles are to be rebuilt or reconconstructed. All the improvements will be completed before January 1.

RICHMOND, VA.—The Southern Bell Telephone and Telegraph Company hopes to begin the operation of its new plant before the middle of July. The progress made upon the work in the company's new building has been very satisfactory, and all the conduit and cable work has been completed. The work of putting in and connecting up the new telephones will be pushed rapidly. The station wiring has been practically completed, and on account of the rapid progress of the work the company will be able to make the change several weeks earlier than was anticipated.

ROCHESTER, N. Y.—Plans are practically completed for the consolidation of the independent telephone lines in Wayne County into one concern, which is to reequip and extend the lines until they embrace every town and village in the county. The company, which is to succeed the independent concerns, will be capitalized at $50,000, an increase of $40,000 over the capitalization of the Wayne Telephone Company. In Lyons, cables will take the place of wires at present in use and an all-night service will be maintained. This change will be adopted in Clyde, Newark and all the larger villages. Through the county generally a complete metallic circuit will be installed and other important improvements made.

KANSAS CITY, MO.—The Missouri & Kansas Telephone Company, usually called the Bell Telephone Company, has concluded at Kansas City two important transactions with Grant Hornaday and C. W. Penniman, of Fort Scott, Kan. The Bell company bought outright the toll lines of the Kansas Telephone Company, which has 350 miles of wire from Fort Scott to Parsons, and covering a field in Missouri and Kansas of which those towns and Iola and Garnett (Kan.), Rich Hill and Nevada (Mo.), and Pittsburg and Girard (Kan.) are the principal points. The value of these lines, said to be the best in Kansas, is about $40,000. In connection with this deal the Bell Telephone Company made a traffic arrangement with the independent telephone company of Pittsburg, Kan., whereby it is understood the Bell exchange and the competing exchange there will consolidate their plants, and one rate will be charged instead of two.

ELECTRICAL SECURITIES

Although the week was shortened by two holidays, substantial progress was made in the direction of high prices. Nearly all the leading stocks closed higher on Thursday than they did at the end of the week before, the improvement extending from fractions to several points. The continued increase in railroad earnings, except those of the strictly anthracite roads, and the continuance of good crop conditions, account for this advance.

The anthracite coal trade continues at a standstill, with the remarkable feature of the ability of the country to get along without a large drain upon the small available supplies. The presumption is that the high price of anthracite is leading consumers wherever possible to use soft coal or gas or oil in preference to replenishing their anthracite bins. The strike situation is unchanged outwardly, although it is believed that considerable numbers of men are anxious to return to work. The soft coal trade is active and the rise in the Ohio River has permitted the shipment of something like 12,000,000 bushels of coal which would ordinarily not have moved at this season.

ELECTRICAL SECURITIES FOR WEEK ENDING JULY 3.

New York:	Closing.
Brooklyn R. T.	67⅞
Con. Gas	224
Gen. Elec	308
Kings Co. Elec	197
Man. El	132
Met. St. Ry	149
N. Y. & N. J. Tel. Co	176
Westinghouse Mfg. Co	212
Boston:	Closing.
Am. Telep. & Tel	165
Edison Elec	280
Mass. Elec. pf	97½
New England Tel	142
Western Telephone & Telegraph	103½

Efforts are being made to reorganize the Michigan Telephone Company. The Western Telephone and Telegraph Company owns about $3,750,000 of the $5,000,000 of the Michigan company's outstanding stock, and substantially all the floating debt which aggregates about $2,200,000.

Philadelphia:	Closing.
Elec. Co. of America	6
Elec. Stor. Bat. c	89¼
Elec. Stor. Bat. pf	88¾
Philadelphia Elec	5⅝
Union Traction	44½
United G. I. Co	108

It is announced that the Electric Company of America has had paid in at the office a large amount of the final assessment of $1 in advance of the expiration of the time limit. The earnings of the company, it is said, continue to show a large increase over last year.

New directors have been elected in each of the twelve street railway companies in the names of which the Philadelphia rapid transit franchises were granted to John M. Mack and his associates. The new board in the case of each company is composed of Messrs. John B. Parsons, George D. Widener, Jeremiah J. Sullivan, Michael Murphy and John M. Mack. These companies were incorporated with five directors each and it was thought best to increase the number.

A prominent director says that the report that the Union Traction earnings for June show a falling off is incorrect. For the first fifteen days of June the Union Traction Company was $46,500 ahead as compared with June, 1901. It is estimated that for the full month the company should be $45,000 ahead.

Chicago:	Closing.
Chicago Edison Light	179
Chicago Telep	170
Metropolitan El. pf	89
National Carbon	23¼
National Carbon pf	97½
Union Traction	16⅝
Union Traction pf	50

The Union Traction Company's fiscal year ends with this month. Earnings from month to month have shown a marked improvement, aggregating about $600,000 over the preceding year, but it is estimated that the increase will be eaten up by increased taxation and operating expenses. The items of increased wages alone, it is said, will amount to nearly $125,000 for the year.

The Metropolitan Elevated traffic in June averaged 101,743 a day, a gain of 15,564 as compared with the corresponding month of last year. Traffic on the South Side Elevated in June averaged 76,449 passengers a day, a gain of 6,804, or nearly ten per cent as compared with the corresponding month of last year.

NEW INCORPORATIONS

OXNARD, CAL.—Oxnard Suburban Electric Company. $10,000. Incorporators and directors: D. S. Perkins, Hueneme; W. J. Wayte and W. V. Lockwood, San Francisco; Simon Cohn, El Rio; L. J. Rose, J. A. Driffill and P. S. Carr, Oxnard.

HILLSBORO, MD.—The Easton Light and Fuel Company, which recently came into existence for the purpose of acquiring the gas and electric light plants in Easton, recently held a meeting in that town, and completed arrangements for the transfer of the property. The officers of the company are: Clarence P. King, of Philadelphia, president; John W. Pittock, of Philadelphia, treasurer; Frank R. Owen, of Denton, secretary. The board of directors are: Clarence P. King; Harry A. Richardson, of Dover, Del.; Judge William R. Martin, of Easton; Fred R. Owens and William H. Deweese,, of Denton. The price paid for the property is said to have been $50,000, and extensive improvements will be made at once. Both of the plants will be duplicated so as to insure against breakdowns, and the corporation is understood to be strongly backed financially.

INDUSTRIAL ITEMS

THE PITTSBURG TRANSFORMER COMPANY, Pittsburg, Pa., with sales agencies in Philadelphia, Chicago and San Francisco, has produced a dainty folder describing this excellent apparatus, which is so attractive that it will not fail to be taken notice of.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is describing its application of motors to motor-driven tools in Bulletin No. 24. This is a splendid specimen of advertising literature. The half-tones are well developed, and the book is bound in a unique coarse fibre hempen cover.

THE C. W. HUNT COMPANY, West New Brighton, S. I., is manufacturing a special hoisting rope which bears the trade name of "Stevedore." The claim is made that this is of such good fibre, and is so perfectly lubricated, that it is endowed with very long life under the most severe conditions of service. This company also manufactures Hunt's patent plumbago laid manilla rope, made of pure selected manilla, unadulterated.

"RURAL SUMMER HOMES," issued by Mr. D. W. Cooke, general passenger agent of the Erie Railroad, New York, is not only an illustrated guide to the summer homes adjacent to New York on this picturesque railroad, but is an example of very attractive typographical art. It is elaborately illustrated and presents very complete descriptions of the many beautiful summer resorts along the line of this road. A map of the lines of the Erie Railroad system, through the land of suburban and summer homes, is an appendix to the volume that will be fully appreciated.

THE CHASE-SHAWMUT COMPANY, Boston, well-known manufacturer of electrical specialties, has entirely reconstructed its factory since the recent fire on a greatly enlarged scale. The number of employés now is doubled. Among the many novel improvements is the installation of a De Laval steam turbine for the generation of both power and lighting for its factory. This steam turbine, for which this company is New England agent, is attracting great attention on the part of those interested in the economic questions of power and lighting. The De Laval steam turbines have been for several years in successful operation in Europe. It is only recently, however, that the De Laval Company has entered this country, but the extensive works at Trenton, N. J., are already overtaxed to meet orders. The Chase-Shawmut Company invites inspection of this turbine, which is in constant and very efficient operation in its factory, 390 Atlantic avenue, Boston.

THE WOODWARD GOVERNOR COMPANY, Rockford, Ill., manufacturer of friction water-wheel governors, was incorporated on June 28, 1902. The following officers were elected at the meeting on that day: A. W. Woodward, president; E. E. Woodward, vice-president and general manager; J. Charles Young, secretary and treasurer. This business was formerly conducted by Messrs. A. W. and E. E. Woodward as a copartnership, but the business reached such a size that it became necessary to secure assistance, and negotiations were opened which resulted in the taking of J. Charles Young into the company. His principal duty will be the conducting of the sales department and outside engineering work. Mr. Young was formerly employed as superintendent of the People's Power Company, Moline, Ill., and also as general manager of the People's Power Company, Davenport, Iowa. The company expects to greatly increase the territory now covered by its governors, which territory includes not only the United States and Canada, but countries in Europe and South America, the export trade at present being large.

PERSONAL MENTION

MR. ISAAC L. RICE has had conferred upon him the degree of LL.D. by Bates College, Maine.

MR. HARRY B. THAYER, of the Western Electric Company, New York, left a few days ago for a tour of England, France and other Continental countries.

MR. FRANK GIBBONS VAUGHAN, of the Schenectady office of the General Electric Company, was married last month to Miss Alma Demick, of Lynn, Mass.

DR. S. S. WHEELER, president of the Crocker-Wheeler Company, is touring Europe on a French automobile. Dr. Wheeler is accompanied by his wife.

MR. ARTHUR D. NEWTON, formerly president of the Eddy Electric Manufacturing Company, has been elected secretary of the Electric Vehicle Company, Hartford, Ct.

MR. A. B. AYRES recently resigned from the Chicago office of the Westinghouse Electric and Manufacturing Company to accept a connection with Sargent & Lundy, engineers, New York.

MR. ALFRED STROMBERG, president of the Stromberg-Carlson Telephone Manufacturing Company, is now in Stockholm, Sweden, visiting the home of his youth. Mr. Stromberg has become prominent in telephone manufacturing circles.

MR. W. R. MASON has resigned from the Sprague Electric Company, and has accepted the position of western manager for Coe, Smith & Company, selling agents for the Mechanical Boiler Cleaner Company, with offices at 413 Western Union Building, Chicago.

MR. CHARLES M. CLARKE has recently issued in pamphlet form through the United Telpherage Company the paper on "Telpherage Methods and Accomplishments," read by him before the American Institute of Electrical Engineers some weeks ago.

MR. E. W. GOLDSCHMIDT who has been identified with the Chicago office of the Bullock Electric Manufacturing Company, has recently assumed the management of the New York office, succeeding Mr. R. T. Lozier who has gone to the home office of the Bullock company, to take charge of the selling organization.

MR. J. W. PETERSON, who was formerly connected with the Chicago sales department of the Stanley Electric Manufacturing Company, and the Northern Electrical Manufacturing Company, has been elected vice-president and general manager of the Electrical Equipment Company, with offices at Suite 939 Monadnock Block, Chicago.

MR. GEORGE F. PORTER, has again returned from Alaska, and before he left had accomplished the successful operation of the Kerite cable which his company laid for the government service. Mr. Porter is to be congratulated over this accomplishment, as it was believed it would be a difficult matter, owing to the rigorous climatic conditions.

COLONEL ALLAN C. BAKEWELL, second vice-president and general manager of the Sprague Electric Company, was recently elected department commander at the New York State Encampment of the Grand Army of Republic held at Saratoga Springs. There was a strong opposition ticket in the field, but Colonel Bakewell, in recognition of his services in both the state and national work of the organization, was elected by a handsome majority.

COLONEL ROBERT C. CLOWRY, president of the Western Union Telegraph Company, has made a number of changes since assuming the presidency tending to the improvement of the company's vast service. Certain positions in the nature of sinecures have been abolished, and stronger men put in others. Many tried employés have had their salaries increased, and several old and loyal attaches relieved from work on a life pension. These changes, under the direction of Colonel Clowry, who is experienced in every detail of the company's service and knows its every need, are working improvements that can not fail to be appreciated by the message-sending public.

LIEUTENANT PAUL D. STOCKLEY, son of Mr. George W. Stockley, former president of the Brush Electric Company, Cleveland, now a resident of New York, it will be remembered disappeared in the Philippines over two years ago and was supposed, at the time, to have been captured and killed by the natives. Recent information received at the War Department, secured from native sources by Major W. H. C. Bowen, of the Fifth Infantry, confirms this. He had been attacked by a band of natives, stoned and shot with his own revolver and, so the natives report, the body was thrown into the deep waters of the lake near Banga, in the Batangas Province. One of the murderers of Lieutenant Stockley was caught and tried by military commission. The remainder are still at large.

OBITUARY NOTICE

MR. CYRUS OSBORNE BAKER died at Newark, N. J., on July 4, 1902, in the seventy-first year of his age. The funeral services were held at his late residence, 41 Franklin street, on Tuesday, July 8, at 2 P. M. Mr. Baker was an uncle of Mr. Cyrus O. Baker, of Baker & Company, platinum refiners, who is very widely known in electrical circles.